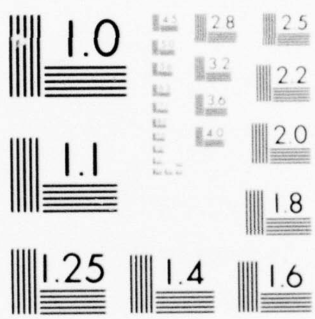
AD-A048 236 OFFICE OF NAVAL RESEARCH LONDON (ENGLAND) F/G 5/2
EUROPEAN SCIENTIFIC NOTES. VOLUME 30, NUMBER 7, (U)
JUL 76 J W MILLER, V S HEWITSON
UNCLASSIFIED ESN-30-7 NL

| OF |
AD
A048236

END
DATE
FILMED
1 -78
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

OFFICE OF NAVAL RESEARCH
LONDON

EUROPEAN SCIENTIFIC NOTES

ESN-30-7

31 JULY 1976

Distributed by the
Office of Naval Research Branch Office,
London

This document is issued primarily for the information of U.S. Government scientific personnel and contractors. It is not considered part of the scientific literature and should not be cited as such.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (14) ESN-30-7	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) EUROPEAN SCIENTIFIC NOTES. Volume 30, Number 7,		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) J. W. Miller and Victoria S. Hewitson editors		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US OFFICE OF NAVAL RESEARCH BRANCH OFFICE LONDON 223/231 Old Marylebone Road London NW1 5TH		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS (12) 54p.		(11) 12. REPORT DATE 31 July 1976
		13. NUMBER OF PAGES 47
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AEROSPACE	EDUCATION	MATERIALS SCI	SPACE SCI
BEHAVIORAL SCIENCES	ELECTRONICS	MEDICAL SCI	
EARTH SCIENCES	ENGINEERING	OCEAN SCI	
	ENVIRONMENTAL SCIENCES	PHYSICAL SCI	
		PSYCHOLOGICAL SCI	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written primarily by members of the staff, of ONRL, with certain articles prepared by, or in cooperation with members of the scientific

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

265 000

LB

20. ABSTRACT (Continued)

staffs of the European Office of Aerospace Research and Development and the European Research Office. Articles are also contributed by visiting Stateside scientists.

EUROPEAN SCIENTIFIC NOTES
OFFICE OF NAVAL RESEARCH
LONDON

Edited by J.W. Miller and Victoria S. Hewitson

31 July 1976 Volume 30, No. 7

European Scientific Notes is Group II Newsletter type Class B periodical prepared and distributed by the Office of Naval Research London in accordance with NAVEXOS-P-35 prepared and submitted by the scientific and technical staff.

James H Schulman
J.H. SCHULMAN
Scientific Director

L. Roy Patterson
L. ROY PATTERSON
Captain, USN
Commanding Officer

AEROSPACE

ONERA

The *Office National d'Etudes et de Recherches Aérospatiales* (National Institute for Aerospace Research and Studies) was founded in 1946 under the authority of the French Ministerial Delegation for Armament (DMA). In 1963 the emerging importance of space programs (or, as it is described in an English translation of a French brochure, "the apparition of space research"), and a reorganization of the French Defense Ministry, shifted the emphasis in ONERA from aeronautics to aerospace (thus changing the meaning of the "A" in the title) and placed the organization under the newly established Directorate for Research and Testing Facilities (DRME). Though ONERA is under the ultimate control of the Defense Ministry, its 30-year history is highlighted by a series of contributions that have benefited a much larger community than that encompassed by defense interests. ONERA is something of a conjugate to NASA in its military control/civilian spinoff character--but differences in the nature of the activities of the two technological behemoths are not easily identified.

This is not surprising, due in part to the strength of the US influence in the formation of such European organizations and to the usual abundance of individuals in positions of leadership who have an acute awareness of and a cordial professional relationship with US scientific and engineering institutions. (Parenthetically, it has become increasingly apparent from this international viewpoint that the question of "Who is influencing whom?" is not so readily answerable as it was in the not-too-distant past.) My host at ONERA, Philippe Poisson-Quinton, exemplifies this observation with his familiarity with the US activities in aerospace research, having recently returned from Princeton where he delivered a series of lectures in aircraft design. We reluctantly truncated a stimulating, if depressing, discussion on the current widespread dearth of design educators and educated designers, so that Poisson-Quinton could assume his roles as Deputy Technical Director of ONERA and as a most effective guide.

The headquarters and main laboratories of ONERA are in the Paris suburb of Chatillon-sous-Bagneux, but the total work force of some 1900 individuals is distributed throughout Paris and across France. The annual budget is about 200-million francs (about $46 million) and is used to support seven departments: (Systems, Aerodynamics, Large Wind Tunnels, Structures, Energetics, Physics, and Materials), a computing center, and a research center at Toulouse (CERT). The direct management of the departments and services is under the Central Scientific Director (Pierre Carrière) and the overall responsibility for the Institute rests with Director General Pierre Contensou. In summarizing the functioning of the rather complex ONERA administrative structure, it can be said that, judging by the past output and current programs at ONERA, it works.

The chief focus of my visit was on the activities of the Aerodynamics Department, and these were reviewed for me by J. Leynaert of the Applied Aerodynamics Division. The Department is well-known for a number of significant developments in aerodynamics, but perhaps the most famous of these is the series of flow-visualization results that are both aesthetically and technically pleasing to the fluid dynamicist's eye. ONERA has pioneered the use of such techniques for obtaining a qualitative "feel" that is essential for the basic understanding required for detailed theoretical or experimental analysis. It is rare, indeed, to walk the halls of any aerodynamics department in the US without seeing examples of the gorgeous colored swirls and eddies that mark the flows past bodies suspended in the water tunnels of Paris.

Besides Leynaert's Division, which will be further described below, the Department contains the Theoretical Aerodynamics Division headed by Henri Viviand. Here, one will find the more-or-less standard categories of inviscid flow, boundary layers, and separated flows and wakes. Current interests center around the theoretical modeling of three-dimensional laminar and turbulent boundary layers, inviscid three-dimensional transonic flows, and shock wave/boundary layer interaction. In their research into transonic flow, the Division has constructed a generalized relaxation

method based upon the transonic small-perturbation approximation to the two-dimensional equations of motion. Using a conservative numerical scheme of the mixed type, the program has been used to calculate inviscid transonic flow in a duct with a hump. The pressure distribution thus obtained is fed back into the program, operating in the indirect mode, which subsequently yields an exact replica of the duct contour--a check of the adequacy of the numerical technique. The Division is also employing the "unsteady" method, in which advantage is taken of the unchanging hyperbolic nature of the equations, regardless of the Mach number of the flow. By allowing the calculations to "run" until the transients have died out, the method has been used to determine the Mach number and pressure distributions over cascade blades in transonic flow. In these and all other theoretical works described to me the Division relies exclusively upon the computer.

The interests and activities of the Applied Aerodynamics Division are roughly parallel, and thereby complementary, to those of the theoretical side. In the area of transonic flows, this Division is conducting a wide-ranging test program to compare various leading- and trailing-edge configurations with theoretical models for ultimate application to helicopter blade profile design and the development of thick subsonic (supercritical) wings. In the latter instance, a 17% thick airfoil profile has been developed that is 50% to 60% thicker than current profiles with an equivalent critical Mach number. Investigations such as these are aimed at improved flight performance near the critical Mach number (the flight Mach number at which severe drag increases occur due to local sonic flow on the wing)--either by increasing airfoil thicknesses without decreasing the critical Mach number, or by increasing the critical Mach number with existing thin wing-profiles.

The Applied Aerodynamics Division is also conducting a comprehensive series of tests and evaluations of the three-dimensional flows past swept wings at both subsonic and transonic speeds. Noteworthy in these tests is the utilization of hot films embedded in the wing surface to signal the occurrence of boundary-layer separation.

Perhaps the most extensive, and certainly a very interesting activity of the Division is an extremely comprehensive program of "confidence building" in wind-tunnel test results. Three schemes for this will be mentioned here. The first of these centers around flight tests--just begun--to examine the separation characteristics of various wing leading edges. Using the in-flight data (obtained by means of the hot-film technique mentioned above), they will make comparisons with both full-scale and sub-scale wind-tunnel tests of an otherwise identical configuration.

Another "confidence builder" is designed to put to rest many of the questions concerning sidewall effects in wind-tunnel tests, especially in transonic flow. The program involves ONERA with several other US, Canadian, and European aerodynamics facilities in the transonic testing of standard airfoils utilizing the various theoretical and experimental tunnel correction techniques favored by each facility. ONERA now has a data-bank of these wind-tunnel comparisons and an operational computer program for the application of corrections to wind-tunnel data obtained over a wide variety of flow conditions, model geometries, and tunnel configurations.

A third example of the ONERA efforts to verify and extend wind-tunnel capabilities is the so-called "Method of the Enlarged Leading Edge." In general, and for high-lift devices in particular, the flow about the leading edge of airfoils is extremely critical since in this area a major portion of the aerodynamic load is sustained and, as a result, pressure gradients are extreme from the point of view of flow separation. It is extremely desirable to examine these regions in detail and at high Reynolds numbers--both factors being limited by wind-tunnel size. The method employed by the Applied Aerodynamics Division is based upon the alteration of the flow past foreshortened downstream surfaces, so that the flow past large-scale leading edges is aerodynamically identical in the wind-tunnel to that in an infinite free-stream. The design of the downstream surfaces, and the blowing that is often required, is obtained from an analytical model which calculates the circulation required to locate the stagnation point at the proper point on the leading edge. Comparisons with actual in-flight measurements indicate excellent agreement for the first 5-10% of the airfoil--the critical region. The results are equally

impressive for leading edges with slats.

No review of activities in aerodynamics would be complete without reference to the most impressive ONERA wind-tunnel capabilities. These are more than twenty in number, and range in size from the continuous subsonic 16-m x 8-m tunnel in Chalais-Meudon to the smallest tunnel at Modane--the 0.5 m diameter hypersonic tunnel. Available tunnel speeds range from 5 m/s to Mach 20, with every imaginable auxiliary capability such as blowing, ground-effect simulation, and combustion. Over a wide range of Mach numbers, Reynolds numbers (based upon the root of the test-section area) of 1-5 x 10^7 are attainable with peak values of almost 10^8 available in S1, the slightly transonic 8-m diameter continuous tunnel at Modane. The French are not resting on their laurels, however, with a large anechoic wind-tunnel scheduled for installation in Saclay, near Paris, and, in the never-ending pursuit of higher Reynolds numbers, the late-1976 commissioning of a continuous pressurized (4-atm) subsonic (100 m/s) tunnel in Le Fauga, about 30 km south of Toulouse. This latter device will have a 4.5-m x 3.5-m test section.

With facilities such as these, and the demonstrated expertise of the experimental and theoretical personnel of its Aerodynamics Department, ONERA is justified in predicting that its 60th anniversary will be as monumental as its 30th has been.
(R. H. Nunn)

BEHAVIORAL SCIENCES

SUBMARINE PSYCHOLOGY AT THE INSTITUTE OF NAVAL MEDICINE

In November 1973, a new $500,000 medical research facility became operational at the Institute of Naval Medicine, Alverstoke, Gosport, Hants., UK. This unique facility is the Environmental Medicine Unit (EMU). It was first proposed in 1967 to serve as a laboratory for the investigation of long-term toxicological problems arising during extended nuclear submarine patrols. Considering that construction began only in 1971, the fact that the first experiment was successfully conducted in 1973 is nothing short of remarkable.

Although the facility was described by J. Vorosmarti (ESN 27-12:340), a brief description is in order here. The focal point of the EMU is a large chamber (12,000 ft^3) which can support up to 12 men in continuous isolation for periods of at least 90 days. The main floor space can be divided into working and recreational areas which contain sleeping facilities, a kitchen, toilets and other amenities for comfortable living. The airtight chamber, which is entered through an airlock, has an excellent atmospheric control system including controls for a wide range of temperature (55-95°F), relative humidity (10-100%) and circulation conditions (20-200 CFM linear airflow). The dry-bulb temperature can be varied over a 35-150°F range. There also is provision for introducing controlled amounts of gases such as CO, CO_2, O_2, etc. The system is designed to simulate the atmospheric and thermal features of any Naval operational environment.

In addition to the chamber itself, the complex includes laboratory support facilities, e.g., state-of-the-art systems in electroencephalography (EEG), electrocardiography (ECG), respiratory and cardiovascular physiology, biological monitoring of body fluids, biochemistry, hematology and microbiology. Experimental monitoring is done from the outside utilizing through-chamber penetrators, closed-circuit television and an audio system. Associated mechanical equipment include a control room incorporating data-recording systems, laboratories, offices and workshops.

Following the completion of construction, a system checkout took place in November 1973, under the direction of Surg. Cdr. D.M. Davies, RN, the laboratory director, who has served as senior investigator for all studies undertaken thus far. At this time four subjects went into isolation in the chamber for a period of 26 days. In addition to developing and refining chamber procedures, an experiment was conducted in which the subjects were exposed to an elevated CO_2 level (1.5%) for a period of 12 days. This served as a pilot study for a longer program which took place in 1974. The 12-day exposure was preceded and followed by a seven-day control and recovery period respectively.

In 1974 an 81-day program was carried out in which the CO_2 level was maintained at 0.5% for a period of 35 days. This experimental period was preceded by a control period of 28 days and followed by an 18-day

recovery period. The principal experimental objectives of this program were to study acid-base status, mineral balance, respiratory physiology, biochemical and hematological status, mental and physical performance, sleep patterns, and psychological reactions to the environment. While the principal investigators felt that the objectives could be accomplished in 50 days, the Royal Navy wanted the subjects to be exposed for approximately the time that men might be exposed on submarine patrols.

The subjects in these experiments were volunteer enlisted men obtained through standard Naval channels. They all were screened both medically and psychologically prior to acceptance for the experiment. They were paid about £2.20 per day depending upon the number of medical tests to which they were subjected.

The subjects varied considerably in their reaction to taking the experimental tests. As would be expected, some tests were disliked more than others. Interestingly, the investigators found that it was necessary to make the lowest priority tests (from the investigators' point of view) the most unacceptable to the subjects. This would assure that the important tests would more likely be carried out. Because the emphasis was on biomedical monitoring the mental-performance test battery was considered to be of the lowest priority by the investigators and was considered the most undesirable by the subjects. By contrast, the blood sampling procedures, which were more painful, were much more acceptable to the subjects and were the highest priority for the investigators. If the subject's resistance to taking the tests in general became too high, the length or frequency of administration of the psychological tests could be shortened thus gaining the undying gratitude of the subjects and ensuring their continued cooperation on the high priority tests. The implications for the construction of psychological tests are all too obvious, i.e., if useful results are desired the tests should have some face validity and be palatable to the subjects.

During a recent visit to the EMU, the writer was able to observe an ongoing program designed to study the effects of prolonged exposure to CO on mental and physical performance. Seven groups of subjects (six-nine per group) each spent three weeks in the chamber. This is the third in a series of studies designed to answer, once and for all, the question of the acceptable level of CO for long-term exposure in a closed environment. In this experiment, three groups of volunteers were exposed to three different levels of CO in otherwise normal air for eight days at each level, with five days in fresh air before and after each exposure. One exposure was to zero CO, while the others were to 15 ppm and 75 ppm CO by volume. All subjects were non-smokers. This is particularly important in a study of this kind because the amount of CO in the blood is raised significantly by smoking, especially in a closed environment. The particular levels of CO were selected because 15 ppm probably will become the acceptable level in the submarine service, and the 75 ppm is the level at which measurable effects are seen in most investigations.

The experiment underway during my visit, in contrast to some of the earlier ones, had as its main purpose the measurement of mental performance in general and on simulated submarine-oriented tasks. In addition, measures of appropriate biochemical parameters were being made.

The psychological studies were divided among six groups. Group 1 tests were given four times daily and included a letter-cancellation test, double-digit addition, logical reasoning, digit span (short term memory) and a memory and search task. These tests were taken simultaneously by all subjects, each of whom had a separate test booth. The Group 2 test was called LOGIT, a strategy and reasoning test, which has been used in a number of environmental conditions. The tests in Group 3 were designed to measure manual dexterity and visual sensitivity. The tests in Group 4 assessed neurophysiological performance and measured finger tremor and body balance. The Group 5 test was an auditory vigilance task in which the subjects were required to detect a signal in a series of similar signals that tended to mask it. The writer was there while this test was being administered and found the task to be both difficult and tedious. The sixth Group was really a selected battery of questionnaires designed to record sleep patterns, motivation in an isolated state, personality, and hostility.

Although the results of this study are not available, certain comments can be made about this type of investigation and about the general psychological factors encountered in the previous studies which also were present in the current one.

It was decided in the second CO study (the one immediately preceding the current one) not to inform the subjects when they would be released from the chamber until after the final tests on the last day of the experiment. Data collected previously showed that tests taken towards the end of the experiment were adversely affected when the subjects knew the termination date. It was found that most subjects were not motivated primarily by money but rather by a pioneering spirit to do something unusual and to assist in medical research. Once a group was selected it was found, in each case, that it was important to cultivate potential leaders while at the same time assuring that the senior subject in the chamber was only one professional or one rank level above the rest of the group. The studies were all conducted on a single-blind basis (the subject being unaware of changes in the environmental conditions).

As in any isolated situation, food was an important consideration. After unsuccessful attempts at having the subjects cook their own food, and bringing in chefs to the laboratory to cook, it was decided to use pre-prepared meals brought in from outside the Institute of Naval Medicine. This worked fine and will be the procedure in all future long term studies. Although it was decided initially to permit the subjects to have access to newspapers and television but not to receive mail or make telephone calls, it was decided later to allow mail delivery on those days when no major experimental procedures were to be carried out. In the opinion of the investigators, the success or failure of the studies depended almost entirely on adequate maintenance of initial motivation and morale. One of the tasks of the investigators, therefore, was to reassure the subjects with respect to the importance of the studies and how they would benefit the Navy.

During the writer's visit to the EMU, there was an opportunity to review and discuss the results of the psychological testing that is currently underway. While the analysis is preliminary and consists of a series of raw data plots, there do not appear to be significant changes in performance on any of the tests as a result of the elevated CO.

The results of these studies, when considered along with previous work, led the investigators to conclude that the level of CO for long term exposure in a closed environment should be 15 ppm. This recommendation is consistent with that of the NASA for long term spaceflight and is what the US Navy began using about 1973. This level is readily attainable by existing CO removal systems on board nuclear submarines. For example, in the Royal Navy's nuclear submarines, the CO level for 90% of dived time on a patrol currently varies between 5-15 ppm. It is interesting to note in this regard that up to 90% of the total atmospheric load of CO in a submarine is produced by tobacco smoking.

Future work in this busy laboratory will be centered on atmospheric contaminants, byproducts of exotic fuels, mental performance under various watchkeeping schedules, physiological effects of continuous inhalation of refrigerant gases and nitrous fumes, and the effects of simulated operational environments on mental and physical performance. (J.W. Miller)

EARTH SCIENCES

EARTH SCIENCES IN OSLO

The mathematical building, a tall structure on the campus of the University of Oslo, in Blindern, houses several institutes among which are the Institute of Geophysics which is divided into three sections: Meteorology-Hydrology (the largest), Oceanography and Solid Earth Geophysics. The Geophysics faculty has diverse research interests including: Effects of mountains on large scale atmospheric flows, dynamic meteorology, numerical weather prediction, radiation, cloud physics and microphysics, photochemistry, atmospheric chemistry, and physical oceanography. I cannot do justice to all these areas and will outline only some of the work underway in the study of effects of mountains on

large scale flows and physical oceanography. I will also briefly discuss the work on convection of Prof. E. Palm of the Institute of Applied Mathematics and Mechanics.

Prof. A. Eliassen is one of three professors in the Meteorology-Hydrology Section of the Institute. He is currently interested in the effects of mountains on large scale atmospheric flows, and has already left his imprint on this field as well as on many other areas of dynamic meteorology. At the time of my visit he had just returned from a Study Conference in Yugoslavia on "Airflow over and around Mountains." This Conference was sponsored by the Joint-Global Atmospheric Research Program (GARP) organizing committee in view of the creation of a possible GARP sub-program on this subject. Such a problem is of importance, as mountains can affect atmospheric motions on a variety of scales of motions: from the very large scale associated with weather systems to those in which clear air turbulence is found. Large scale flow modification due to mountains has never been properly observed or realistically modeled mathematically or numerically because mountains are difficult to include in numerical models of these flows. The difficulty arises because the horizontal width of a mountain range is usually small compared to the horizontal grid size used in the numerical model. Yet, preliminary observational evidence shows that, for example, the Alps play an important part in the formation of low pressure centers which occur in the lee of these mountains. These centers which form in the Gulf of Genoa have a profound effect on the weather in Southern Europe.

Research is carried out to determine under what conditions a large scale atmospheric flow will go over or around a large scale, three-dimensional obstacle. This work is complemented by the development of a non-linear numerical model on which one of Eliassen's students is working. A three-dimensional "mountain" of large horizontal dimensions is placed in a "box" having for its horizontal dimensions several times those of the obstacle. Periodic boundary conditions are used; Eliassen is unhappy about these conditions, for the wake of the mountain reappears upstream of the obstacle. "Open" boundary conditions would remedy this drawback, but they are much more difficult to handle, especially if internal gravity waves are allowed to be present. A new feature of their model is the use of potential temperature as a vertical coordinate. (The potential temperature of an air parcel is the temperature of that parcel when brought down to sea level without loss of heat.) Such a coordinate is more appropriate than the vertical height for the study of such flows, but one runs into numerical difficulties when the mountain intersects surfaces of constant potential temperature.

Prof. O. Saelen is involved in a sizable field program designed to gather information on the Norwegian Coastal Current. He pointed out that, at present, there is more information on the Atlantic Current than on the Norwegian Coastal Current. The mechanism responsible for driving such a current is still not well understood. Fresh water running seawards from the numerous fjords might provide such a driving mechanism. The field program integrates efforts in chemical, biological and physical oceanography and brings together all of the major marine institutions and universities of that country, as well as seven ships. In May-June 1975, several traverses were made normal to the Norwegian coastline and hydrographic, biological and hydrocarbon data were collected and analysed. Current measurements are very difficult to make and long-time series are needed before one can ascertain the accuracy and repeatability of a given set of data. The gathering of a long time series is somewhat facilitated by a Norwegian regulation which forces oil companies operating in Norwegian waters to record several of the observable meteorological and wave-current parameters. Saelen hopes that next year there will be a recap in the early spring and late summer of the 1975 program, but on a smaller scale.

Palm is one of the two professors of the Institute of Applied Mathematics and Mechanics. The other chair is in the process of being filled. Palm's present research is concerned with explaining regular polygonal patterns of stones found in sub-polar regions (East Greenland); these regular patterns of stones have a linear dimension of some 1-4 m when occurring on flat terrain. Palm and one of his students are using a theory akin to thermal convection to seek a possible explanation for these features. In these sub-polar regions the soil is

very muddy during the thawing period in spring. Stones are embedded in a layer of 1-2 m of mud which rests over a crust of eternal ice. Wind blowing on that muddy surface dries out part of the soil, which then becomes denser and begins to sink. Therefore, circulations similar to those found in thermally-driven convection might be set-up. Palm explained that frost is also responsible for the motion of these stones. Because stones have a larger heat-diffusion coefficient than the surrounding soil, freezing begins near the stone. Water vapor gradients are set-up which create differences in density in the ground and therefore induce vertical motions. Palm conceded that, at this time, their theory is somewhat speculative due to lack of data on these types of soils. His student is checking some of the theoretical predictions by means of an experiment on convection in a porous medium (glass beads form a matrix through which water flows). This experimental effort is carried out in a laboratory that the Applied Mathematics Institute is in the process of setting up in the basement of the building.

Keeping up with their tradition, the Institutes of Geophysics and Applied Mathematics and Mechanics at the University of Oslo provide an exciting environment in which to pursue advanced studies in dynamic meteorology and in problems dealing with the broad subject of geophysical fluid dynamics. (A. Barcilon)

EDUCATION

WHAT'S IN A TITLE?

In liaison visits to universities and research institutions in foreign countries, one often encounters people who carry the title "Doctor" or "Professor." This, of course, is not unusual in itself. However, in recent visits to Italy, I was perplexed by two things that had to do with people's titles. First, I was introduced to a number of young people who were addressed as Doctors, but who were working at jobs which would not normally be assigned to PhD's. Furthermore, some of these people appeared hardly old enough to be PhD's. Could it be that they started their schooling early and were over-educated for their respective jobs? I wondered. The second thing which struck me as odd was the fact that some senior researchers were addressed as Professors even though they were not members of an academic faculty and had never taught at a university before. How does one become a Professor at a non-academic institution? The answers to both of these questions lie in the degree system in Italy; it is quite different from the BS-MS-PhD gradation with which we are familiar. Entrance to a university in Italy is preceded by 13 years of schooling: five years in a primary school, three years in a lower secondary school and five years in a higher secondary school. Education is compulsory and free for children between the ages of six and fourteen. Students studying engineering normally spend five years at a university. When they graduate, they are awarded a Doctor of Engineering (Dr. Ing.) degree. There are no further academic degrees, such as PhD, beyond that, except for the teacher's diploma to be described later. It is therefore quite normal that a person acquires a Dr. Ing. degree in Italy at age 24, and since this is not a research degree (the requirement of a thesis notwithstanding), the bearer is not expected to do a PhD's work.

In actuality, the Italian Dr. Ing. is probably closer to a Master of Science (MS) degree in US or a Diplom Ingenieur (Dip. Ing.) degree in most of the rest of the European continent. The usual impression that a Dr. Ing. in Europe is equivalent to a PhD in US does not hold true in Italy. Other aspects of university education in Italy have been reported previously (ESN 30-4:155).

How does one acquire the title of "Professor" in Italy without being a professor? This could be done in the following way. A productive research worker may, usually five or more years after the acquisition of the Doctor's degree, submit his published works and other qualifications to an examining committee of five members. After having evaluated his qualifications and accomplishments the committee schedules a lengthy interview with the candidate, delving into his work in detail. On the second day, the candidate draws by lottery a topic from a list of topics in his general area of competence. He is given half-a-day to prepare and is then required to deliver a lecture on that topic. The committee will

question him and judge his performance. If the committee passes him, he is then qualified for the "*Libera Docenza*" (literally, free teacher's diploma) and is entitled to be called "Professor" whether or not he teaches. I was told, however, that the entire university structure in Italy has been undergoing change for the past three years. Already, important decisions such as academic programs, research directions, salary distributions, and load assignments are made in general assemblies where professors, assistants, and technicians have equal voices and equal rights. *Libra Docenza* is to be eliminated. What will happen to academic degrees is uncertain, but "What's in a title?" will remain a sensible question in Italy for a while.

In Spain I was puzzled by the different grades of professorships at Spanish universities. At first, it was somewhat confusing to note that almost everybody on the academic staff, including some very young people, carried the title "Professor." I subsequently found out that there are at least five kinds of *profesores*. Their complete titles and the corresponding ranks at US universities are roughly as shown in the following table.

ACADEMIC RANKS	
Spain	USA
Catedrático	Full Professor
Profesor Agregado	Associate Professor
Profesor Adjunto	Assistant Professor
Profesor Contratado	Adjunct Professor
Professor Ayudante	Graduate Professor

A Doctor's degree is required for the first three categories: namely, *Catedráticos*, *Profesores agregados* and *Profesores adjuntos*, which all carry tenure. *Profesores contratados* are hired on contract for their knowledge in a particular field to teach special courses. *Profesores ayudantes* help in recitation or laboratory classes. They are *Ingenieros* employed by universities on two-year contracts which are renewable for a second two-year period; hence, *Profesores ayudantes* are, in fact, not professors in the usual sense. It is interesting to note that there are two kinds of *Ingenieros* which are radically different. The first kind is the regular *Ingenieros* who are graduates of five-year programs from *Escuelas Técnicas Superiores*, and the second kind is the *Ingenieros Técnicas* who are graduates of three-year programs from *Escuelas Universitarias*. Here again is an example of the importance of knowing what's in a title.

The position of *Catedrático de Universidad* (University Chair Professor) carries a high honor. It is equivalent to the Head of an institute. To be appointed a *Catedrático*, a *Profesor agregado* (or, in very rare cases, a *Profesor adjunto*) must apply for the position when one becomes available. He, along with other applicants, must go through a screening procedure by a special committee set up by the Minister of Education. The committee first scrutinizes the qualifications of all applicants and interviews each candidate individually. Next, each candidate is invited to lecture for one hour on a subject he is expected to teach. The third step is for each candidate to choose a topic from a list of ten to twelve technical topics and write for three hours a state-of-the-art review of the topic. Most of us will probably think that these three steps represent a sufficient screening process. But there is yet a fourth step. The candidates are required to solve in three hours a collection of problems supplied by the screening committee. The committee usually takes at least fifteen days to make its decision and announce its choice. There is little doubt that those who do not make it will be mentally and emotionally thoroughly beaten men.

What's in the title *Catedrático de Universidad*? Apparently a great deal. Besides the honor and authority associated with the tenured position, I was told that the beginning *Catedráticos* have a monthly salary of about the equivalent of $1100 with double pay for the months of July and December. This is quite high in Spain. Annual salary increases are automatic and the income tax rate is in the range of 15 to 18 percent.

In this article I have tried to clarify the meaning of some of the academic titles in Italy and Spain. These titles may appear similar to what we normally encounter, but their

meaning may be quite different. It is well that we do understand their true significance. (D.K. Cheng)

ELECTRONICS

ELECTRONICS RESEARCH AT UCL

The University College London (UCL), founded in 1826, is the largest and oldest college of the University of London. It now enrolls about 5500 students. The full-time academic staff numbers approximately 700 including 120 professors, of whom 29 are Fellows of the Royal Society.

The College is composed of six Faculties: Arts, Science, Economics, Engineering, Law, and Medicine. The Faculty of Engineering at UCL, established in 1908, was the first of its kind in the UK. It now has five departments: Chemical Engineering, Civil and Municipal Engineering, Electronic and Electrical Engineering, Mechanical Engineering, and Photogrammetry and Surveying. There are about 500 engineering students and 80 members of staff which include 13 professors.

The Electronic and Electrical Engineering Department at UCL had a distinguished beginning. The first occupant of the Pender Chair which carries with it the headship of the Department was Professor J.A. Fleming, later Sir Ambrose Fleming. Fleming patented his invention of the thermionic vacuum tube in 1904 which was the beginning of the electronic age. The present Pender Professor and Head of Department is A.L. Cullen, a well-known educator and researcher in electromagnetic theory and microwaves. The departmental personnel list contains 18 academic staff, one research fellow, three research assistants, ten experimental and technical officers, fourteen technicians, two computer programmers, and five secretarial and administrative personnel. There are normally 30 to 35 students in each year of the three-year first-degree courses in electronic and electrical engineering and about 35 postgraduate students working for the PhD degree.

Research work in the Department is divided roughly into three groups: an Electromagnetics Group headed by Cullen; a Physical Electronics Group headed by Professor E.A. Ash; and a Systems Group headed by Professor D.E.N. Davies. In a recent visit to UCL, I talked at length with Ash and Davies and was conducted through their laboratories. Cullen was away in France on his sabbatical leave, but Dr. J.R. Forrest explained the research work of the Electromagnetics Group to me in a most competent manner.

Electromagnetics Group - The research work of the Electromagnetics Group is currently concentrated in three main areas; namely, active antenna arrays, microwave measurements, and electromagnetic theory. The active-array work involves locking theory, techniques for phase control, and the effect of amplitude and phase errors in the radiating elements, each with its own solid-state oscillator. The development of an electronically steered solid-state active phased-array system for radar applications has attracted much interest recently because of its potential advantages in size, weight, reliability, and the elimination of the need for high-voltage power supplies. However, high cost and system complexity have restricted its use. Cullen and Forrest at UCL have tried to reduce the cost for phase-shifting in two ways. The first method uses an interpolation-locking technique in which the phase shifter and locking-line connection of every other element in an array are removed. The phases of those elements whose phase shifters have been removed are expected to be properly maintained by interpolation through mutual coupling from their directly-locked neighbors. There are several limitations to this method. First, the sum of the coupled signals from the neighboring directly-locked elements may be too small to effect an interpolation lock for certain element spacings. This limits the maximum scan angle. Secondly, the technique is probably applicable only to arrays with a uniform amplitude excitation. Thirdly, the effects of coupling from elements other than the nearest neighbors and of amplitude and phase errors are difficult to estimate. Nevertheless, UCL has constructed and successfully tested a seven-element transmitting array using 100-mW IMPATT oscillators operating at 9.4 GHz. Possibilities of interpolation locking over two intermediate elements and of application to two-dimensional arrays are being studied.

The second method for reducing

the cost of phase-shifting involves locking the oscillators of the array elements with a reference signal which has a frequency close to a harmonic of the oscillator frequency. The oscillator output can be advanced or retarded by one cycle of the harmonic frequency when pulses of an appropriate amplitude and duration are applied to the dc circuitry. This one-cycle change corresponds to a phase shift of 360/n degrees at the fundamental frequency, where n is the harmonic number. This method eliminates the need for passive phase shifters altogether. The price to pay is in the expense of providing extra microwave circuitry at the harmonic frequency. In addition, harmonic locking becomes progressively more difficult as n increases. UCL has demonstrated this novel technique with a four-element L-band (1-GHz) array using transistor oscillators locked at S-band (4 GHz).

In the microwave measurements area, Cullen's group has obtained accurate results in measuring the permittivity and loss tangent of a dielectric at X-band using an open resonator in a homodyne and phase-locked loop scheme. In contrast to the conventional superheterodyne method using two sweepers and a stabilizer, this new scheme uses only a single sweeper and needs no stabilizer. The Marconi Instrument Company is supporting a project for developing a fully automatic microwave impedance-measuring apparatus. A triangulation technique is used to determine the unknown reflection coefficient. Relevant to the automatic microwave impedance bridge project, a six-port multihole waveguide directional coupler is being designed and constructed. Current work on electromagnetic theory at UCL covers a wide range of problems involving wave-guiding structures and the theoretical analysis of their properties.

Physical Electronics Group - The work of this group falls in four main areas: semiconductor device simulation, acoustic signal processing and imaging, integrated optics, and certain aspects of thin-film materials. Ash, the Head of this Group, is well-known and very active in professional circles. There are now two projects on semiconductor device simulation. One is concerned with the use of the FSP (Full Simulation Program) as a research tool in the study of large-signal noise and instability in millimeter-wave oscillators and amplifiers, and the other is on the modeling of high-efficiency GaAs IMPATTs. The success on the latter project has led to an agreement on an exchange of simulation and experimental results with the Research Division of Raytheon in the US.

In the acoustical signal processing and imaging area, SAW holography is used to detect small surface defects. The output of an amplitude-phase scan of the acoustic field at a point "downstream" is digitized on a computer, and the reconstruction is carried out in near real-time on the same machine. Other studies on SAW devices include mode analysis of resonators and fabrication of thermally stabilized disc delay lines.

Much activity exists in the integrated optics area. Two projects are concerned with the coupling problem: one aims to develop an efficient coupler for optical fiber bundles, and the other seeks to demonstrate that co-linear coupling between a single-mode fiber and single-mode thin film can be effected by an etched grating of an appropriate pitch. Preliminary experiments in coupling fiber bundles by matching the holograms of bundle-ends have achieved a crosstalk level of less than -50 dB.

The development of an electro-optical switch which will switch the output from one multimode optical fiber to one of several other multimode fibers with a low insertion loss and a low cross-talk is the subject of another project. An electro-optical grating switch is to be fabricated on in-diffused lithium niobate. The Physical Electronis Group at UCL has been working on diffused optical-waveguide technology since 1974. Methods for inserting signals onto and extracting signals from a multimode optical-fiber data highway are also under study.

Certain apsects of thin-film research relevant to the on-going acoustic and optical programs are being undertaken. One of the major obstacles to the use of thin-film waveguides lies in the difficulty of finding two compatible, low-loss materials. The possibilities of Ti-diffused $LiNbO_3$ as the material for SAW waveguides and for long delay lines are being studied. Other related investigations include techniques for gas-doping of glass films, automatic control of rf sputtering conditions, and fabrication of planar optical waveguides by ion-exchange in a glass substrate.

Systems Group - The scope of the activities of this group extends over five areas: digital systems, optical-fiber communications, instrumentation for propagation measurements, antenna arrays, and transponders. Some of the activities overlap with those of the other two groups. I first met Davies, Head of this group, at the University of Birmingham in 1960. Between his academic careers at Birmingham and UCL, he served as the Assistant Director of Research for British Rail for four years.

In the digital systems area, this group is investigating methods for simulating electrical components by digital hardware. Resistive, capacitive and inductive components have been designed using binary rate multipliers. Potential applications include very-low-frequency filters. Work is also being done on the application of microprocessors to traffic control and to parallel-processing systems.

As a consequence of an earlier study on optical phase modulators, a new form of optical-fiber telemetry highway using phase-modulated piezoelectric transducers along an optical fiber is being tested. The cascaded clip-on phase modulators form a linear FDM (frequency division multiplex) link and the modulating signals may be recovered by filtration.

Variations of the refractive index of the atmosphere between the terminals of a microwave link cause multipath and scintillation fading. Two radio links at 36 GHz and 110 GHz now operate between UCL and Imperial College across central London, and propagation measurements are being taken to study the variation of clear-air absorption and the effects of precipitation at these frequencies. In addition to the necessary instrumentation for measuring meteorological parameters, a lightweight microwave radio refractometer has been designed to make refractivity measurements. An acoustic radar operating at 1730 Hz produces data on the temperature structure of the first 400 m of the atmosphere.

Under development at UCL is a null-steering antenna array for a VHF mobile radio communication system. It is a four-element circular array with its associated feed circuitry that provides a near-omnidirectional coverage in the horizontal plane except for a steerable null with a controllable width. The frequency range is 130-160 MHz. Also under development is a coded identity transponder which, on interrogation by an appropriate radio signal, gives a coded reply indicating the identity number of the transponder. Two types of transponders, one passive and the other active, are under consideration and experimental models have been constructed.

It is obvious that the electronics research activities at UCL are varied and of high quality. The staff and students of the Electronic and Electrical Engineering Department are proud that they follow in the footsteps of Sir Ambrose Fleming. To this observer their pride appears justified.
(D.K. Cheng)

ENGINEERING

INTERNATIONAL CRYOGENIC ENGINEERING

Grenoble, France is the site of several major cryogenic installations, perhaps more than any other area in Europe. This fact made it a logical site for the Sixth International Cryogenic Engineering Conference, ICEC6, which was held 11-14 May at the Alpes Congrès Centre. The meeting was sponsored by the International Cryogenic Engineering Committee (ICEC), Commission AZ of the International Institute of Refrigeration (IIR), and le Centre de Recherches sur les Très Basses Températures de Grenoble (CRTBT) of the Centre National de la Recherches Scientifique, CNRS. Professor A. Lacaze, Director of CRTBT-CNRS, chaired the local committee which did an excellent job of organizing both the informal and scientific portions of the meeting. The program included parallel visits one afternoon to (1) the laboratories of Centre d'Etudes Nucleaires de Grenoble, involved in special applications of physics and low temperatures, (2) the nearby laboratories of L'Air Liquide, Centre d'Etudes Cryogeniques de Sassenage, (3) the joint French-German-British High Flux Beam reactor at the Institut Laue Langevin, and (4) the CNRS laboratories associated with high magnetic fields as well as the CRTBT.

The meeting consisted of seven plenary talks (which were generally a little lackluster) and about 150

contributed papers distributed among three parallel sessions. The schedule was not tight, more than one informal discussion session was organized during the meeting, and there was time to visit the 15 exhibitions of cryogenic equipment in the adjoining building, "Alpexpo." About 400 were in attendance-less than one would expect given the site and the subject, but the presummer date may explain the decrease. It was certainly interesting to attend a conference in France with English the official language. However, French was used in the informal discussions since only about 15% of those attending spoke English as their first language--about three dozen Englishmen and two dozen Americans. The USSR participants, of which there were a dozen and a half, appeared without preregistration and gave six post-deadline papers on a wide range of topics. This is a change from the usual late cancellation of Russian conference contributions.

An unusual feature of this Conference was the specialized discussion meetings--not just site visits--held the week following at various locations in Europe. These small (less than 20 participants) one-day meetings were not a formal part of ICEC6 but were sponsored by Commission A1, 2 of the IIR. On the Monday following the conference week Professor W. Heinz held "Superconducting Magnet Technology for Fusion" at Karlsruhe and Drs. G. Bogner and P. Penczynski had "Superconducting Cables" at Siemens in Erlangen. The next day Dr. G. Bronca chaired "Large Superconducting Magnets and Cryogenic Engineering in Nuclear Physics" at Saclay and Professor A. Citron ran "Superconducting in Electron Optics." On Wednesday, Professor G. Klipping held "Technical and Organizational Problems in Cryogenics Centers" in Berlin. These discussions will not be reported in the Proceedings of ICEC6, which is due to be published within six months by IPC Science and Technology Press, Ltd., Guildford, publishers of *Cryogenics*.

In this article I will comment on the plenary talks and a couple of the contributed sessions. In a companion article I will report on my visit to the CNRS laboratories of Grenoble, the contents of the ICEC6 sessions on refrigeration below 1 K and a special discussion meeting on dilution refrigeration.

During the Opening remarks Professor Mendelssohn (Chairman of the ICEC) reviewed the French connection with Cryogenic Engineering since the late 19th century and Dr. M. Anquez (IIR, Paris) outlined some recent major changes in the IIR. Anquez mentioned that Dr. B. Birmingham (NBS, Boulder) has replaced Dr. E. Hammel (Los Alamos Scientific Laboratory) as chairman of Section A. Commissions A1 Cryogenics chaired by Professor L. Lounasmaa (Helsinki) and A-2 Cryoengineering, chaired by Professor Mendelssohn have been merged into A1,2 with the recognition that much of the fundamental research in cryogenics is adequately covered by the LT conferences sponsored by the International Union of Pure and Applied Physics. Though not publicly discussed at this meeting, one of the IIR's difficulties is that the US contribution must be laboriously collected from various sources rather than being a governmental contribution as it is with all other member countries.

Dr. M.S. McAshan (Stanford University) reviewed the general problems in gravitational radiation detection and the engineering aspects of the plans for the magnetically-levitated 5000-kg superconducting antennae to be operated below 100 mK at Stanford and Louisiana State University. He mentioned that a low-noise x-band maser amplifier under development at Stanford by R. Gifford may be the answer to the detector problems.

Professor F. Irie (Kyushu University, Fukuoka) discussed the status of the applications of the Josephson Effect. He outlined the various fabrications of these junctions such as the point contact and thin film techniques, and divided the devices into four categories. The first category depends on the voltage-frequency converting ability, and Irie mentioned that since 1972, when the CCE recommended using this property ($f=(2e/h)V$, $(2e/h) = 483{,}594.0$ GHz/V) as a voltage standard, several countries have accepted it in place of the chemical cell standards. He then gave a quick review of the Superconducting Quantum Interference Devices (SQUID) and their use as dc or rf-biased circuits as voltmeters, gradiometers, geophysical gravimeters, and magnetometers, and in medical instrumentation. Most of these devices are now available on the open market. Irie discussed

the use of Josephson junctions as computer elements where their characteristics--fast switching (less than 200 psec) and low power consumption (about 1 μmW/gate--have a clear potential. The final category, the use of Josephson junctions as non-linear inductor, has given rise to radiation detection circuits with a sensitivity of 10^{-14} W/Hz.

Dr. F.R. Fickett (NBS, Boulder) reviewed our (lack of) knowledge of the structural properties of materials for low temperatures. This paper was a guide to some obscure US reports on low-temperature structural properties and advertised the NBS programs and new monographs on the subject. He believes that it is time to quit assuming that high temperature materials are the best for low temperature utilization and that plastics--and especially composites--are very useful at low temperatures. Fickett pointed out that appropriate structural quantities with which to characterize these anisotropic materials have not yet been defined. He expressed the hope that the field would be sufficiently mature by August 1977 (the time of the combined Cryogenic Engineering and International Cryogenic Materials conferences in Boulder) that such definitions could be made. Fickett, in an informal session, also reviewed the "Structural Properties of Superconducting Materials" meeting recently held at Boulder.

Professor Ø. Fischer (University of Geneva) spoke on new high-performing superconducting materials. Superconducting critical currents and fields are now sufficiently high that it is the structural parameters of the materials that determine which cable can be used. Nevertheless, there are many applications where the critical field and current need to be increased. Fischer went on to outline the international status of the work on the ternary molybdenum sulfides and niobium-aluminum-germanium materials. When high critical currents at temperatures are required close to the critical temperature, the ternary molybdenum sulfides are very attractive; but fabrication will be difficult because of their brittle nature.

Two invited talks were given concerning rotating electrical machinery with superconducting windings. Professor R.G. Scurlock (University of Southampton) sketched the thermodynamics of the liquid helium coolant and the attendant problems in such machinery. For example, in a 1-m-diameter 3600-rpm system, 42-K helium at 1 atm injected on-axis would be supercritical (5.6 K and 18 atm) when it reaches the rim. He pointed out that in reality some sort of mixed flow will obtain. Dr. J.L. Sabrie (Electricité de France, Clamart) reviewed the problems seen from the electrical industry's point-of-view. He felt there would be a superconducting alternator of at least 100 MW in the French power grid by 1982, but the government's decision will not be reached until 1978-9.

A large portion of the contributed papers at this Conference in some way or other pertained to fusion research. For example, all seven papers presented on cryopumping were motivated by fusion reactors. But I found the session on cryogenic transmission lines to be fascinating. It was very interesting that only five talks were given and only half of these involved superconductors. Professor N. Kurti, who retired from Oxford last September, was in good form as the provocateur for the well-attended session. T. Matsui reported on the work at Sumitomo Electric, Osaka, on an ac 500-kV 10-GW superinsulated unit-construction rigid line. Several cables including ones of Nb-Ti-Zr (Hitachi), V_3Ga (SEI), Nb (CERL), and Nb_3Sn (BNL) were investigated and the losses were lowest at 4.2 K for 60 Hz for the Nb_3Sn conductor. Matsui indicated the insulation is still insufficient and will require improvement before a cryogenic envelope design is acceptable.

I. Kirschener (Roland Eötrös University, Budapest) described test cables; one 1-m long dc 10-kV 5 MW; another 2.5-m long single-phase 100-kV 100 MW; and a planned 2.5-m-long 3-phase 100 MW cable which will use coolant flowing through the conductor.

E. Forsyth reviewed the progress and plans of the ac superconducting cable at Brookhaven National Laboratory. The planned engineering model will be a 138-kV 100-m section. Forsyth also outlined two superconducting design studies which Brookhaven has made with Cryenco, Boulder. For a superconducting alternative to the planned resistive 4.8-GW at 345-kV line from the reactor stations on Long Island, 42%, 28% and 7% of total costs were for the cryogenic envelope, cable and refrigeration, respectively. In the second design study, for the 11.0-GW 550-kV (or maybe 1300-kV) line from the planned Pennsylvania nuclear park, 28%, 48% and 6% of the total costs were for

the cryogenic envelope, cable, and refrigeration, respectively. In this case the cable itself is gas-tight and contains the coolant with a far-end expander, heat-exchanger arrangement which would require a refrigerator about every 60 km.

Kurti's questions brought out several interesting facts. Two thousand miles of cable of the present design will store (not use--it's recycled) 10% of the helium that is supposed to be stored in the US Tip Top field (E. Forsyth). The refrigeration costs will be about 7-1/2% of the energy transported, based upon the US electrical transmission companies accounting procedures (E. Forsyth). The necessary "insurance" against failure of a transmission line required by transmission companies can add 50% to the capital investment (J. Dean, LASL). All agreed that the 3-4 GW mark is required before a superconducting line is competitive with the present technology, as discussed at ICEC6. G. Bogner (Siemens AG, Erlangen) commented that such lines will not be a reality in Europe until the year 2000. As he sees it, this will allow time to learn about dielectrics and electrical breakdown. At the present time a conventional overhead transmission line is still about three times less expensive; only when the transmission companies are forced to go underground will superconducting lines be seriously considered.

W. Toscano (Cryogenic Technology, Waltham, MA) described the interesting concept of a cryogenic resistive line cooled by liquefied natural gas (LNG) which itself is being transmitted to be burned or stored at the destination of the electrical power. One of the difficulties with this concept is that LNG is required mostly in the winter months while electrical power is used mostly in the summer months. Toscano described a system with LNG pumps every 10 km which transports 3000 A in 3-phase and LNG at 6.33 kg/sec. He has mathematically modeled the systems based on a liquid nitrogen-cooled cable design by M. Graneau (MIT), and investigated the behavior under various fault conditions.

The Conference was closed with the announcement that ICEC7 would be held 4-7 July 1978 at Imperial College, London. Professor J.P. Gardner of British Oxygen Corporation, Ltd., London, of the local committee is ready to entertain ideas for plenary talks.
(T.A. Kitchens)

ENVIRONMENTAL SCIENCES

FORECASTING IN BLINDERN

The Norwegian Meteorological Institute, housed in modern buildings, is located on the campus of the University of Oslo in Blindern. Dr. R. Fjortoft has been the Institute Director for the last 20 years. He is also an adjunct Professor at the Institute of Geophysics at the University of Oslo. The main responsibility of the Institute is forecasting, which now includes not only short-range weather predictions but also wave-swell forecasting and oil-slick movements. An effort is currently underway to infer the so-called "risk events" (extremes in rain or lack of it, wind, waves, etc.) from climatological and statistical data. This recent diversification in forecasting activities is indicative of Norway's emergence as an oil-producing country, with most of the oil fields being located on the continental shelf. The Norwegian government requires all oil drilling platforms to collect and disseminate wave, weather, and current data. The Institute is used as a data bank for such information. There are many users of these forecasts including the general public, both civil and military aviation, as well as the fisheries and agricultural enterprises. Also, due to the presence of numerous mountains and the intensive use of hydroelectricity, forecasts in hydrometeorology are of prime importance and are carried out by the Institute.

The Institute is divided into three main sections: Forecasting, Climatology, and Hydrometeorology which are supported by Data Processing, Instrumentation and Research branches. Research is "applied" in the sense that it is aimed at improving the Institute services to users. Fjortoft, aside from his duties as director, is group leader of the Research Branch, although as he told me, the group is quite informal and he does not care too much for the above-mentioned title. Work is currently underway to learn more from short-time series that are obtained for meteorological conditions prevailing on land or on the open sea. These are sequences of observations that are taken over a period of time. According to Fjortoft, engineers are too impatient, and time series spanning five or ten years are insufficient to predict risk

events. Statistical simulations that attempt to extend these time series are now under investigation. This kind of information is used for design of oil platforms, dams, etc. For example, the model for swell- and wave-forecasts will be used with past meteorological data to provide hindcast information on sea state. This is to be compared with statistical simulation of time series to understand how successfully such simulations can predict risk events.

Dr. H. Økland is looking at ways of improving an operational 48-hour numerical weather forecasting model. The open boundaries of this model introduce some difficulties that are not yet resolved. Further, this more sophisticated model, although using more computer time, does not perform appreciably better than the old operational one. I also discussed with Dr. J. Nordo the problems of acid rain in Norway and of long range transport of SO_2 (ESN 30-4:171). The southern part of Norway is exposed to the highly industrialized belt of Northern Europe, and mountains found on the west coast of Norway compound the problem due to formation of rain with wet deposition of SO_2. It appears that research so far has not been able to establish positive proof that SO_2 acidity is harmful to forests. As far as fish population is concerned, there are probably simple remedies like placing limestone boulders near the waterfalls, etc., which might counteract some of the harmful effects of decreased pH in rivers and streams.
(A. Barcilon)

METEOROLOGY AT RISØ, DENMARK

In the last few weeks, the Atomic Energy Commission Research Establishment, Risø, Denmark, has seen its name changed to Research Establishment, Risø. This alteration also brings about a restructuring, for now this Establishment is under the Ministry of Commerce, which deals with energy-related matters, rather than being, as it previously was, under the Ministry of Education, thus reflecting Denmark's concern for energy resources and research connected with energy.

I visited Dr. N. Busch, head of the meteorology section, who sees the primary responsibilities of this unit as still lying in the area of nuclear research with emphasis being placed on power production. However, he feels that now other kinds of research, both basic and applied, will be fostered. Busch sees the Establishment as becoming a national laboratory similar to Harwell in the UK. The character of the research thrust in the future will depend, at least in part, upon the Danish Parliament's decision on whether or not utility companies will be allowed to build nuclear power plants. The issue is, if you will excuse the pun, a hot one, and the environmentalist's opposition to these plants has been very vociferous; yet Busch feels that such opposition does not represent the preponderance of Danish public opinion. There is even talk that Parliament might settle the question by means of a public referendum. According to Busch, this might be a rather unfortunate step, for the general public is not sufficiently knowledgeable to make such a decision.

Busch's group numbers about nine scientists backed by some seven technicians; its research activities are rather varied (see below). Busch's justification for tackling such diverse problems lies in the very small number of centers in Denmark dealing with research in meteorology. According to him, "my group cannot afford the luxury of treating only a limited, narrow area, but must strive to keep abreast in several areas in meteorology." The research effort is divided into four areas: The first, and by far the one where the largest effort is concentrated, deals with studies of atmospheric boundary layers over both the ground and the sea. This effort includes theoretical and numerical studies in turbulence, as well as field programs. Several papers have been published jointly with faculty members from the Meteorology Department of Pennsylvania State University. The field programs are many; one was carried out as part of the Joint North Sea Wave Project (JONSWAP) in which a string of instruments was laid off the Island of Sylt, FRG, primarily for the purpose of sensing turbulent fluxes in the first 20 m of the atmospheric boundary layer. In Denmark, three towers are set-up in a line normal to shore in the Roskilde Fjord (the Establishment is on the shores of that Fjord) in a region where the difference in height between land and sea is small. At a different location, such height

transition was found to have a strong effect upon the wind profile downstream from the shore.

Aside from this field program, I was shown the 120-m instrumented tower and the 50-m "portable" tower located on the grounds of the Establishment. These platforms have devices to record meteorological fields continuously on various time scales. It is from these large data sets that one can select the simplest meteorological "events" for mathematical modeling and analysis. One area of research using these data deals with changes in boundary-layer flow behavior as the roughness of the underlying surface changes abruptly, such as occurs when air moves from land to sea. Such a study is underway in a joint program with Dr. E. Petersen (Department of Atmospheric Sciences, Oregon University).

The second area of research deals with the compilation of climatological data and the maintenance of stations and instruments used for such purposes. In particular, "Station Nord" which, until recently was the only manned station north of 81°N, in Greenland, has been converted to an automated station. There are now five automated stations in Greenland and some ten others in Denmark. Data from these stations will be used for site evaluations in the event that nuclear power stations are constructed.

The third area of research deals with the development of meteorological sensors. Some will be used for routine observations in the automated stations, while others fall into the category of sophisticated prototype hardware to be used for research purposes.

The last area of research treats problems of an applied nature: air pollution studies; site evaluation for nuclear plants; gust loading of structures in wind; vibrations of cylindrical "buildings" etc. For example, a joint project with the Technical University of Trondheim in Norway dealt with the motions of a suspended bridge under wind forcing. Three-dimensional wind measurements were carried out at various locations. Similar measurements were made adjacent to a lighthouse in the Bay of Helgoland in a joint program with the Institut für Wasserbau, University of Karlsruhe, FRG. In the near future, Busch's group will measure plume characteristics downwind from a 50-m chimney using the 50-m "portable" tower which will be installed, in turn, in five different locations.

Thus, although small, and deriving its research from "practical problems," Busch's group appears to be actively involved in theoretical, numerical field research dealing with, among other things, atmospheric boundary layer flows. It's contacts with other European and US centers working in the same field help overcome the very small number of Danish centers involved in the same area and provide this group with the intellectual surroundings needed for such work. (A. Barcilon)

MATERIALS SCIENCE

A JOINT METALLURGY DEPARTMENT AT MANCHESTER

Two long-standing Departments of Metallurgy, one at the University of Manchester, Faculty of Science, the other at the University of Manchester-Institute of Science and Technology, have joined forces to become a most formidable academic group in materials. The Departments, in their previous separate existences, were chaired by Prof. Edwin Smith (UM) and Prof. K.M. Entwistle (UMIST), respectively, and these two well-established academics have together seen the new group develop over the first year. They are both chairing the new Department, cooperatively, as it were, and succeeding admirably. Their way, it must be admitted, has been smoothed somewhat as a result of provision by the University of an excellent new building and a considerable amount of capital equipment. The net result to date is a staff of 30 faculty and a student body of 40. There are numerous supported research programs, and the facilities, especially for materials characterization, are outstanding. I should like to present a brief outline of some of the programs.

Smith is engaged in theoretical work on fracture; more recently he has been doing micromechanical modeling to study plastic-flow concentration and its effect on the failure of Zircalloy cladding. This work, which is being done in collaboration with the US Electrical Power Research Institute, is related to light-water reactor fuel-rod research programs. Smith is also carrying out a detailed theoretical study on the possibility of having

plane-strain cumulative fractures in the absence of holes forming ahead of the propagating crack tips. He is studying dislocation models as applied to flow instability in two-phase materials. Smith, who is a very productive and imaginative worker, seems to carry on with great enthusiasm in spite of the absence of a cadre of graduate students.

Entwistle is less active in research than in previous years due, in part, to his current deanship of the faculty. One interesting study which he is supervising involves the resolution kinetics of Guinier-Preston I zones in aged Al-3.5 wt.%Cu. A research student, John Ormerod, is using electrical resistivity, scanning differential calorimetry, and transmission electron microscopy to follow the selective reversion of zones on the up-quenching of alloys previously aged at 130°C. Apparently, a reversion size-effect has been detected, i.e., they feel that zones below a certain size will dissolve at a given resolution temperature (say 150°C); and to dissolve more zones, the temperature must be increased further still. The classical reversion temperature would then be that temperature above which no zones are visible, i.e., the coherent solvus. This problem is complicated due to the non-monotonic nature of the resistivity changes which occur both on zone formation and on zone resolution. This approach may not be too profitable due to the competing features of the reactions. But the present rediscovery of Guinier-Preston zones that has occurred in France has appeared to cross the English Channel.

In a more applied vein, Entwistle is studying the internal stresses in cold-drawn steel wires, with special attention to the distribution of the stress as a function of radius. He is also making a study of load transfer between the high tensile strength reinforcing wires in high-pressure hose. Together with Senior Lecturer, Dr. F.H. Hayes, Entwistle is studying the loss of magnesium from Aℓ-Mg-Si alloys during solution treatment in air of fine wire and sheet specimens.

Dr. Norman Ridley, a Senior Lecturer, has a long-term research program on pearlite formation and, in more recent years, on superplasticity. In the latter case, he is interested principally in the failure mechanism which occurs during superplastic flow which limits the high degree of ductility needed to make this process commercially feasible. The origin of the usual failures, according to Ridley, is the formation of voids or cavities, which upon elongation open and eventually lead to failure. This cavitation differs from one material to another, but generally appears to be associated with the volume fraction of second phase particles, mostly at grain boundaries. Thus, the prototype alloy system Pb-Sn shows no cavitation, but on the introduction of silver--to form the hard, intermetallic compound Ag_3Sn--cavitation occurs. In addition to at-temperature mechanical properties studies, Ridley is also examining the room-temperature mechanical properties following superplastic deformation. Ridley and his students have studied copper-base alloys (α/β brass and α/β Cu-Zn-Ni) and a range of steels. On the subject of ferrous metallurgy, Ridley is still supervising programs on precipitation in W/Mo steels, with special reference to the relation between microstructure and mechanical properties and, together with Dr. G.W. Lorimer, he has been investigating the partitioning kinetics of alloying elements during the austenite-to-pearlite transformation. The alloying elements in question include Ni, Mn, Cr, Aℓ and Si.

Dr. G.W. Lorimer, a Lecturer, and formerly a postgraduate researcher at Cambridge during that institution's electron microscopy heyday, is an extremely active force in the Department. Previously with the UM Department, he recognizes the great difficulties involved in bringing the two Departments together. Lorimer, with talent and good will, has assisted in the accomplishment of this feat. For example, the melding of the vast electron microscopic equipment from the two Departments with equipment purchased for the new building, must, Lorimer recognizes, be handled very fairly and diplomatically. It appears he is succeeding in accomplishing this. The electron metallography facility is a well-equippped and extremely well-coordinated operation. This is especially true of the analytical electron microscope EMMA-4, which has been in operation for four years. The unit more recently has been fitted with a Kevex energy dispersive detector. The great versatility and potential of this instrument can be appreciated by a brief review of some of the projects which have been and are currently being carried out.

Directionally solidified eutectic Al-$CuAl_2$ was investigated to determine if a copper concentration-gradient exists near the solid-liquid interface of the aluminum-rich phase. Though no such gradient was detected, this eutectic proved to be ideal for monitoring the effect of specimen thickness on the x-ray intensity ratios. Partitioning of alloying elements in eutectoid steels, as discussed above, proved to be an excellent problem for EMMA analysis. Currently, two steels are being investigated: Fe-0.8 wt.%C-20Wt.%Si and Fe-0.8 wt.%C-2 wt.%Cr-2 wt.%Mn. Initial results for the Si-containing steel point to preferential silicon partitioning to the carbide phase. Resolution of the frequently fine lamellar spacing in these systems, however, introduces difficulties.

Additional work on steels, carried out with Ridley, is in progress. Tempering of 6 wt.%W-3 wt.%Cr-0.3 wt.%V-0.3 wt.%C tool steel is being studied with special interest in the distribution within $M_{23}C_6/M_6C$ carbides of Cr, Fe, W and V. Also being studied with EMMA is the marine alloy, Cu-Ni-Cr. The mode of decomposition of quenched alloys has been studied at Manchester, with research being carried out to determine whether the initial reaction is spinodal or nucleation and growth. This work of graduate research assistant I. S Saunderson was originally directed by Dr. Peter Wilkes before he left to join the faculty of the University of Wisconsin. Saunderson, in fact, has joined Wilkes as a postdoctoral assistant. Currently, EMMA is being used to determine the compositions of the later cellular product.

In the earth sciences, a field in which Lorimer has involved himself deeply, iron meteorities are being studied to determine nickel concentration at α/γ boundaries. This work is being carried out in collaboration with Professor J. Goldstein of Lehigh University, who has been studying the composition of meteorites for some time. Further on geology, Lorimer and his wife, Dr. P.E. Champness of the Geology Faculty, have been using TEM and EMMA to study naturally occurring minerals. They have looked extensively at exsolution in silicates, with special reference to pyroxenes, based on compositions within the system composed of the following end-members: $Mg_2Si_2O_6$ - $CaMgSi_2O_6$ - $CaFeSi_2O_6$ - $Fe_2Si_2O_6$. The range of tie lines available in natural occurring minerals based on this system makes it fertile for much study. A range of transformation types and morphologies exist in these cases: from spinodal decomposition to interesting cellular products. Also of great interest are the observations of defects which have long been studied by materials scientists but which have received careful attention from geologists only recently. A fair amount of work has been done on the alkali feldspars, with $NaAlSi_3O_8$ - $KAlSi_3O_8$ representing an excellent example of a spinodally decomposing mineral. Much of this very interesting work has been reviewed recently by Champness and Lorimer in a new volume, *Electron Microscopy in Minerology*, edited by H.R. Wenk *et al.* Springer-Verlag, 1976.

Further work with EMMA will include interface diffusion studies on oriented bi-crystals. In addition, the large range of cooperative programs in geology and physical metallurgy, both outside and within the University, will be emphasized. Also on the subject of earth science, Dr. H.J. Axon, a Reader, is continuing studies of lunar material (with Goldstein of Lehigh) and of meteorites. They, in fact, have studied Apollo lunar samples.

Dr. F.R. Sale, a Lecturer, and specialist on chemical metallurgy, is producing and characterizing fine tungsten and molybdenum powders, as well as tungsten alloys. The tungsten powder is being produced from conventionally-crystallized and freeze-dried ammonium paratungstate. The products are then compared by thermogravimetry in a controlled hydrogen/water-vapor atmosphere. Sale is also studying the chlorination of oxide-spinel ores and refractories using a static bed reactor. He also has programs on vapor deposition of carbides (e.g., to form Cr_3C_2). In other chemical metallurgy programs, Hayes is studying the thermodynamic properties of a range of magnesium alloys, and R.A.J. Shelton, a Reader, is doing aqueous chlorination on nickeliferous laterite ores. Shelton is also vapor-plating titanium by the decomposition of volatile halides.

It was possible for me to meet with only a few of the 30 faculty. (I was disappointed at not being able to meet with Dr. P.E. Evans, a specialist on particulate materials and interfaces, since he was preparing for the annual single-handed Atlantic sailboat race--

the UM flag was about to courageously cross the Atlantic... !) It was clear that the new, joint Department is alive and moving. What with the new facilities and a certain visible mood of excitement, there was an air of the "good old days" of ten years ago--when, internationally, the growth curves were pointing upwards. Such a mood is rare anywhere these days. So it is with great pleasure that I am reporting this visit--and with a degree of optimism. The developments at Manchester will warrant our continuing attention. (H. Herman)

SOLAR FURNACES IN THE PYRENEES

A hot dog can be cooked on the cheap with a small solar furnace (a parabolic mirror) which is available at many local "drug" stores. Zirconia, with a melting point of about 2700°C, can be melted in a matter of minutes in much the same way--for about the same price (long term capitalization and salaries not considered). In the southwest of France, within the shadows of the Pyrenees, is the Laboratoire des Ultra-Réfractaires at Odeillo. This CNRS-supported laboratory, unique in its dedication to the utilization of solar energy for the treatment and study of refractory materials, is directed by Dr. Marc Foex an elderly member of the French scientific establishment and a man who is highly respected by his staff and the students who work at Odeillo.

The "Sun Lab" (a term used widely in the Press) was founded in the late 1950's and has, since its initiation, grown around a central and numerous subsidiary solar furnaces. The central furnace, an impressive feat of technology and public relations, represents the logo of the Laboratory. In reality, however, for materials research, this mirror is far less important than it might appear-- though the entire Laboratory building is actually built around it. Rather, a collection of well-positioned and cleverly-controlled "small" parabolic mirrors (at least a meter in diameter) are the mainstays of the research programs. In fact, a wide variety of solar furnaces is available. The typical work-horse, however, consists of a former German WWII anti-aircraft searchlight (the quality is there--and the price is right--I hope this doesn't start a run on the surplus searchlight market!). The average parabolic mirror is 1.5 m in diameter, with a 0.85 m focal length. The specimen, sitting at the focus, can receive 2 kW on a sunny day. For such a mirror, the focal spot is about 6 mm in diameter. A plane mirror, which, depending on the arrangement, can follow the sun, directs the sunlight to a parabolic mirror which focuses it onto the specimen chamber. The chambers range from a simple table to a quartz double-walled (water-cooled) controlled atmosphere unit for melting or vaporization studies.

The location of Odeillo is, of course, ideal, there being some 3200 hours of sunlight annually. The geographical isolation is a problem, but between skiing and the sun, one hears few complaints. One man mentioned to me that Nice has more than 3300 hours of sunlight, but the high level of water moisture makes the location unsuitable for a solar lab. One can't have everything.

Dr. M. Ducarroir is involved mainly in chemical vapor deposition (CVD) studies of refractory carbides. The first step in this work, according to Ducarroir, is the careful determination of phase equilibria in the complex systems which are employed. For example, in an attempt to obtain TiC by CVD techniques using $TiC\ell_4$, methane and hydrogen, it is essential to understand Ti-C-H-Cℓ equilibria. This is done by a program of free energy minimization (frequently together with workers at the Centre d'Information de Thermodynamique Chimique Minérale of Grenoble). These computer calculations take into account the condensed phases, together with their appropriate free energy functions and the standard heats of formation for the given chemical species. The details of the procedure are outlined in a recent publication, *Journal of Less Common Metals* 40:165 (1975).

B_4C has also been subject to this approach. Ducarroir and C. Bernard (of the Grenoble lab) have evaluated phase equilibria of the solid deposits for B-C-H-Cℓ vapor system. In the case of this system, as well as others, an electronic balance is used to follow the kinetics of formation of the solid phases, by means of the rate at which mass changes. In addition, modern techniques of analysis are used to characterize the obtained coatings and solid specimens (x-rays, microprobe, electron microscopy). In the case of TiC, an orientation-dependence of the deposited film is associated with the partial

pressures of $TiCl_4$ and CH_4, and this is being studied throughout the TiC single phase domain. Ducarroir and co-workers are also developing a program on composite carbides formed *in situ*. For example, in the low vapor pressure range, they obtain two-phase solid equilibrium of TiC + Ti, and for higher pressures of CH_4, TiC + C.

Most of the work on CVD is carried out in normal high-temperature furnaces, but Ducarroir showed me a variety of arc-imaging and solar furnaces that have been used very effectively in this program.

Ducarroir is involved, together with F. Sibieude, in an interesting program for making hydrogen in a two-step thermochemical cycle. Normally, most "practical" hydrogen generation schemes involve five or six steps. They, however, would like to reduce the number of reactions by going to higher temperatures--enter the sun! For example, the equilibrium $ZnO=Zn+1/2\ O_2$ occurs at about 2200 K, which is close to the temperature at the focus of a solar furnace. This thermal decomposition reaction thus, it is hoped, yields zinc metal in a fine powder form. The metal powder, in water vapor at approximately 1400 K, will yield ZnO + H_2. The efficiency for this scheme is currently too low, but the chemistry is interesting. This, then, represents a way of using solar energy to make hydrogen for fuel systems. They are currently examining this concept and are also considering other oxides to be used in the process.

Of course, the best way to make hydrogen is by direct conversion from water vapor. This has been attempted at Odeillo. A stream of superheated steam is introduced through a crucible which is at the focus of a parabolic mirror--aimed at the sun. The exiting gas is then analyzed by mass spectrometry and the output measured. The hydrogen concentration in the vapor was found to be 2-3%. The yield is low, intriguing and it merits serious consideration.

J.P. Coutures is an active individual, interested mainly in rare-earth oxides. He is studying the physicochemical properties of Ln_2O_3-Al_2O_3 and Ln_2O_3-Ga_2O_3 glass-like compounds (where Ln = La, Ce, Pr, Nd, Sm, Eu, Gd, Tb), formed by splat-cooling the molten materials. Obviously, melting is done with the sun, and, in fact, the stuff melts like butter. The splatting device is very dramatic, a large hammer sweeping down and flattening the globules. The resulting specimens are flaky glasses, which are then studied with differential thermal analysis, x-rays and infrared absorption methods. Portions of this work are done cooperatively with the Laboratoire des Terres Rares, CNRS (Centre National de la Recherche Scientifique), at Meudon-Bellevue. Coutures has also done transpiration studies of non-stoichiometric uranium dioxide at temperatures above 2000°C. He has thus been able to find boiling points of this oxide system as well as a range of rare-earth metal sesquioxides. Using the solar furnace, Coutures and his wife Juliette have synthesized and studied $CeLnO_3$ (where Ln = Tm, Yb, and Lu) and $PrLnO_3$ (where Ln = Yb and Lu). They have also formed and studied the crystal structures of the system lanthanum oxychromate and yttric rare-earth sesquioxides. From making new compounds, including glassy substances, to thermodynamic and structural studies, Coutures' group excels. They use the sun, arc-imaging furnaces and high power lasers in an experimental program that is an outstanding example of innovation in refractories research.

Another program was shown to me by J.P. Traverse, who has been studying the interaction of nitrogen with molten alumina or zirconia. He has been using a pressure chamber (125 atm) in which the oxides can be melted. The oxygen and nitrogen pressures are controllable, and the forms of the nitrides that result are studied. Phase diagram determinations, in this program, as well as with Coutures' work, play an important role in the Laboratory.

C. Bonet runs the plasma laboratory at Odeillo. He and his group are responsible for the design and applications of high temperature plasma chemistry and plasma processing. The Laboratory has devised a plasma fluidized-bed reactor for the processing of super-refractory powders. They have carried out studies of the heat transfer between the rotating water-cooled wall and the plasma jet. Temperature measurement and gas-flow control are of paramount importance in such systems, and Bonet and his group have been optimizing these parameters. They have also built and are studying the characteristics of three-phase plasma arc generators. I was shown an interesting nitrogen arc generator with three symmetric electrodes, designed to operate at 200 kW for one hour. Bonet also discussed a clever

plasma device utilizing a refractory oxide cathode for forming an oxidizing plasma. The unit I saw uses zirconia stabilized with calcium. This system, which actually works, has great promise.

The programs that I saw at Odeillo were of high caliber, and the possibilities rendered me slightly dizzy--or perhaps it was the thinness of the air at those altitudes. These techniques, which are simple but highly effective, can lead to new research programs--to those of us in Arizona or the Sahara or the Negev, etc. The possibilities are limited only by one's imagination--and by the weather. (H. Herman)

SPUTTERING IN FRENCH

I hope readers of ESN are not misled by the title of this article. Certainly all materials scientists should know that Sir Joseph John Thomson used the term "spluttering," which is synonymous with "sputtering," to describe the process of film deposition of the cathode material in a chamber containing a low pressure plasma of gas subjected to a high dc voltage. It is doubtful that he used it to describe his son's (Sir George P. Thomson) rapid table conversation during porridge that year--Sir George was already 32--although he may have done so about 1895. What is less well known is that the basic process of sputtering or "cathode disintegration" was clear to F. Stark even earlier, in 1909. He believed that the cathodic material was pulverized into particles of atomic dimension and ejected as a result of the momentum transfer from the bombarding gas ions.

Even commercial interest in this process is not new--Western Electric was using dc sputtering to place a uniform conductive coating on the wax Ediphone masters in 1928. What is new is the growing interest in surface and plasma physics; an accelerating commercial use of thin films; and ac sputtering which allows almost any (source) material to be reliably deposited on almost any other (substrate) material while maintaining the source stoichiometry, if desired, and providing generally greater adhesion than other film-depositing processes.

In mid-May the French Vacuum Society, *Société Francaise du Vide* (SFV), held the 2ème Colloque et ses Application (the Second International Colloquium on Sputtering and its Applications) CIP 76, at the Institut *Universitaire de Technologie* of the Université de Nice. The meeting was sponsored by the French Ministries of Industry and Commerce, Interior, and Education. Nearly 50 papers were presented during the four-day meeting, roughly half of which were in English, although there were only a dozen British plus Americans present. In order to avoid many parallel sessions, there was a poster session with about 20 contributions, nearly half of which were also in English. Most of the poster contributions concerned equipment or thin film applications, topics very suitable for this type of presentation. Those of us who had difficulties with spoken French were very appreciative of the organizing committee's (especially that of Mr. P. Pileur (IBM France)) concern and translation of questions and answers. We were also happy to find that the French papers often followed verbatim the written summaries which had been supplied at the beginning of the meeting. Nevertheless, the language barrier, the lack of common housing for the meeting, the Nice beach, the Cannes Film Festival, and other local attractions curtailed the social and informal scientific interactions among the 200 attendees, which are the usual collateral benefits of scientific colloquia.

Associated with the conference was an exhibition by some 20 commercial firms of vacuum and thin-film deposition equipment. Many of the displays were of complete systems for the commercial production of thin films, reflecting the fact that about one-third of the attendees were employed by commercial firms. Perhaps the most impressive of these was the new SL series deposition systems manufactured by Electrotech (Santa Clara, California). The remainder of the exhibits were on surface-analysis techniques, miscellaneous vacuum equipment, and fast cryopumps. An enormous cryopump (30,000 liters/sec of air at 10^{-8} torr), manufactured by Physiméca, Saclay, and incorporating a Philips K20 cryogenerator, was described by J. Clergeot in a contributed talk.

Several of the eight plenary talks were significant. One of the most fundamental was given by Dr. A. Ricard (Laboratoire de Physique des Plasmas, Université Paris-Sud, Orsay).

Reactive sputtering, i.e., sputtering in a gas which reacts with the sputtered material as it moves through the plasma or as it resides on the substrate, is poorly understood, and Ricard's work is an attempt to pave the way to a better understanding. He discussed the theoretical aspects of reactions in plasmas with number densities similar to those encountered in sputtering. The creation and annihilation of excited atoms, such as Ar, and molecules, such as N_2, CO, and CO_2, is governed by electron collisions (the principal creation mechanism), collisions with excited neutrals, losses due to diffusion, and the conservation of the number of particles of each chemical species. With a grasp on these processes, Ricard moved on to consider the transfer of both ionization and excitation, and provided a tabulation of the experimentally determined reaction rates for H_2, N_2, O_2, and H_2O for (1) charge transfer from Ar^+, (2) excitation transfer for the $Ar(^3P_2, ^3P_0)$ transition. He ended with an illustration of the use of this table. Charge transfer appears to dominate in H_2 and possibly so in N_2, but for O_2 excitation transfer through the $Ar(^3P_2, ^3P_0)$ transition appears to dominate.

Dr. E. Kay (IBM, San Jose) also spoke on plasma chemical reactions, in particular polymerization. He reviewed the industrial uses of plasma polymerization and presented a large amount of qualitative information on cross-linked and non cross-linked polymers; the analytic spectroscopic techniques currently applicable to polymeric films; and the role of various chemical species such as CF_4, C_2F_4, HF, and H, as well as photons, electrons, and impurity ions in the polymerization. Kay went over the reasons for the lack of reproducible qualitative information on the subject and described his experimental work with J. Coburn to obtain reliable data. Kay argued that it is important to determine the residence time of the gas in question accurately and to account for the fact that the chemical cross sections are largest in the range of 10-20 eV. This suggests that the electric field distribution, especially in the low voltage range, determines the chemistry and the deposition rates.

Certainly one of the most active participants at the conference was Professor C. H. Weissmantel (Technische Hochschule Karl-Marx-Stadt, East Germany). He contributed knowledgeably at the "debate session" (question period) on the application of ion-bombardment techniques and presented a plenary talk on the utilization of ion beams for etching and film deposition. He described the plasmatrons, magnetrons and the ion source designed by L. G. Finkelstein (Bell Laboratories, Allentown, PA) in some detail. Weissmantel surveyed the space-charge effects and the phenomenon of the formation of microscopic cones on the specimen surface by ion-etching. He presented his work on depositing a Si_2N_4 film using dual beam deposition, one beam of Si and the other of N_2. This work is described in C. Weissmantel, *Thin Solid Films* 32, 11 (1976). The question of the mechanism of ion-plating was raised and discussed. Perhaps Weissmantel's new ion-source which controls the ion current and energy independently may, in time, provide some of the answers.

Professor G. K. Wehner (Electrical Engineering Department, University of Minnesota) gave the initial plenary talk, "Sputtering of Multicomponent Materials." He pointed out that although we know a good deal about the basic sputtering process, there are several very fundamental observations that have not been explained, such as, why the sputtering threshold-energies are independent of the sputtering gas ion mass and generally four times the target sublimation-temperature, and why the average velocity of sputtered $Z > 20$ atoms lies in the narrow band between 4 and 8 x 10^5 cm/sec. Wehner spoke on cone formation in aluminum. Apparently, cone formation is strongly dependent on impurities and the cones can be removed by bombardment with either O_2 or N_2. The cones do not form when the target is well cooled, possibly due to suppressed surface migration. He noted that the cones never extend past the original surface for low gas pressures and low voltages. Wehner then reviewed the use of sputtering as an analytical tool and presented several examples from his depth-profile investigations of the components in compounds and metallic alloys in an apparatus incorporating a sputter depositor, a sputter cleaner, and an Auger spectrometer. In this very clear review of the subject, he also gave one example of a "knock-in" process. When a dilute AgAℓ alloy is subjected to 2-keV Ar^+ bombardment, the Ag atoms are knocked into the bulk, as can be seen by gently sputter-etching at

~ 500 eV.

"Measurements of Film Substrate Bond Strength by Laser Spallation" was given by Dr. J. L. Vossen (RCA Laboratories, Princeton, NJ). The hardware was very impressive, and the technique may provide quantitative results, but some additional development is necessary. Dr. L. G. Feinstein (Bell Laboratories, Allentown) gave a beautifully clear plenary talk, in French, on deposition of unusual materials in the manufacture of integrated circuits. The subject was a bit wide-of-the-mark for this conference but the work was impressive. Dr. M. Hayashi (ULVAC, Japan) presented recent Japanese work on the deposition of chromium on steel for corrosion protection and of cobalt on plastic tapes for superior magnetic recording. He also spoke on the details of reactive sputtering for Cr_3C_2 from Cr in C_2H_2, CrN from Cr in N_2, and TiC from Ti in acetylene. In the contributed session, M. Hecq (Université de l'Etat à Mons, Belgium) provided a review and a good account of his work on dc reactive sputtering of cobalt in O_2 to prepare β-Co, CoO and Co_3O_4 films. By x-ray diffraction and fluorescence, he studied the films which were deposited on amorphous substrates. The deposition rate of each chemical composition was sharply dependent on the O_2 partial pressure and the total gas pressure.

In the final plenary talk, Dr. J. P. Decosterd (Balzers A.G., Liechtenstein) presented a detailed critique of the various analytical means of studying sputtered films and their interfaces. The paper was more like a chapter from a good textbook, complete with the pertinent equations and remarks about the idiosyncracies of each technique. He covered ion scattering, secondary ion mass, Auger electron and the photoelectron spectroscopies.

Many of the contributed papers at this conference pressed the frontiers of sputtering more than the plenary talks, but were more pragmatic. For example, there were several papers on reactive sputtering, but often the result would be the conditions under which a sufficient deposition rate could be obtained, with no attempt to analyze why or to give the necessary information to allow analysis at a later date. Perhaps reproducibility of the product will always outweigh real understanding at this level of development. But such a statement is too strong; there were some careful complete investigations reported.

For example, J. Jolly (L.T.T., Conflans-Ste-Honorine, France) gave a very complete account of his comparison of the resistance and its temperature-coefficient for reactively sputtered tantalum nitride using diode, triode, and a flat magnetron arrangement for various pressures, excitation voltage, and gas composition. M. Jan (Centre National d'Etudes des Télécommunications, Lannion) presented a new technique for measuring the local electron density and temperature in a plasma. He thoroughly described a spherical resonance probe which agrees with the Langmuir probe in the noble gas plasmas and is now studying organic vapor plasmas in order to probe the problems of plasma chemistry. Dr. G. Dagoury (CEN - Saclay) gave an almost overly detailed account of their work on several stainless steels, platinum, graphite, boron carbide and other materials that may be present on the containing walls of controlled thermonuclear devices. In one apparatus, they can use Auger and Secondary-Ion mass-spectroscopies and thermal desorption analysis on such materials after bombardment by ions or neutrals. In the poster session, Dr. M. Snykers (Joint European Torus Design Group, Culham) also spoke on the wall materials for a fusion device, especially the low Z elements. BN might be very suitable, but the expense may not allow its use. Dr. G. Gautherin (Université Paris-Sud, Orsay) presented some work on sputtered superconducting films of NbTi and Nb. For Nb, the greatest superconducting transition 4.45 K was found when xenon gas was used. G. F. Piacentini (Telettra S.P.a. Vimarcote, Itay) gave an interesting account of the structural and transport properties in thin films of sputtered tantalum nitrides deposited under various conditions. Out of the imbroglio of data, he finds the nearly-free-electron model to suffice.

The summaries of most all the presentations at this colloquium are available in supplement No. 182 to the review "*Le Vide, Les Couches Minces.*" The third meeting of this colloquium will be in 1978.

(T. A. Kitchens)

TECHNION MATERIALS SCIENCE

The Technion is THE engineering school in Israel, and it has a Department of Materials Engineering of which, by any measure, it should be proud. The Department administers a graduate program only; thus, like so many graduate materials activities, it is most difficult to come up with student numbers to populate an active research program. But with enough input of students trained in chemistry, physics, or mechanical engineering, the programs appear to thrive.

The teaching faculty numbers less than 15, including three Professors. Furthermore, the Department has an asset which is unique; The nearby Israel Metals Institute, a contract research organization, "In the Service of Industry." There is a clear mutual benefit which arises due to the proximity of the academic unit (the "Department") and the industrial unit (the "Institute"). The faculty consults for the Institute, and the students receive, by a sort of educational osmosis, the benefits of active industrial research.

Prof. Abraham Rosen is currently Department Chairman (in the popular hot-potato game of rotating chairmanship). Rosen, who received all of his training at the Technion, is engaged in research on the aging of Duraluminum, following the process by use of electrical resistance, hardness and ultrasonic attenuation measurements. Together with Dr. S. Dirnfeld, he is studying the influence of annealing on strain aging behavior in this alloy. Rosen is a busy administrator who appears to find time to work on joint programs with a number of his colleagues.

Prof. David Brandon, a transplant from Cambridge, England, has an active program in field-ion microscopy (FIM). A graduate research assistant, Meir Etzion, working with Brandon in a study of interfacial structure, has been attempting to image the interface between two phases. They are limited to a system that will be stable in a high field, so the natural candidate is tungsten/tungsten carbide. An evaporation procedure is used to coat carbon on a tungstun tip, followed by an anneal. Etzion characterizes the thus-obtained FIM pattern as "fly specks." A 3-in.-dia. plate for image amplification seems to improve the pattern; but, as yet, not appreciably. They are concurrently working on Ni evaporated on W--and hope to image the interface between W (which has a low solubility for Ni) and the ordered phase, Ni_4W. The latter was studied some years ago by Newman and Hren at the University of Florida, and this success with the ordered structure gives Brandon and Etzion some hope of being able to resolve and characterize the interphase boundary.

Ion implantation at the Technion was inaugurated July, 1975 in a big way. Installed within the confines of the Solid State Physics Group (first cousins of Materials Engineering), is a 350-kV ion accelerator, capable of accelerating any ion up to 250 mass units at currents to 50 μA. The ion beam is switchable by a magnet to one of two targets, one being capable of 3 x 3 inch sweep while the other is used for channeling and radiation effects experiments. Semiconductors are being examined by the Microelectronics Laboratory (of the Electrical Engineering Dept.). Three staff members are studying the electrical effects of implanting dopants into Si and narrow gap semiconductors (e.g., InSb). Channeling radiation damage experiments are being carried out on single crystal InSb.

The implantation laboratory has been in business for somewhat less than a year, but the ideas are flying, and it appears that between industry and the locals, the laboratory schedule will be saturated in no time.

Dr. Dov Katz supervises an effort on the chemistry and physics of polymers, with an accent on the correlation between properties and microstructure. The work in this group is mainly on epoxies (e.g., EPON 826, Shell). They simply combine the resin with cross-linker and obtain a rigid thermosetting polymer. The goal of the studies is to develop expertise on the structure and properties of composites such as glass-reinforced plastics. From that point of view they are examining the degree of wettability of glass fibers by the resin (with and without wetting agents). The group is also carrying out an extensive investigation on the rheological properties of the epoxy under the simultaneous influences of heat and stress. I met a Russian chap who is starting a study of the electrical properties of polymer films for use as circuit components. Miss A. Buchman described her work on rubbers combined with asbestos; in order to

develop a fire-resistant rubber. She showed me striking Scanning Electron Micrographs (SEM) of this material, both before and after straining and heating. Severe alignment develops, the globular polymer structure transforming to a fibrous structure, and then finally peeling at 60% of the rupture strain. They are looking at such effects as a function of how cross-linking is introduced. Completing the properties studies are investigations of creep, torsional strain and dilatometry. These properties are being related to the SEM-observed structure and the mode of cross-linking.

Dr. Isaac Minkoff, an English-born Israeli who received his PhD from MIT, has an active program on solidification of high strength light-metal alloys. He feels strongly that computer techniques should be generally employed in solidification research and practice in dealing with fluid and heat flow problems, especially those related to solute segregation. Minkoff believes that the Israeli metals industry should become more self-sufficient. The country currently does a good deal of its own forging of alloy steels, but the ingots are imported. He and his students are developing expertise in welding as well, with special emphasis on using computer methods to analyze microsegregation during welding. This is a particular problem with the welding of stainless steels.

Dr. Joseph Yahalom received his PhD from Cambridge in 1963 and, like many of his Israeli colleagues, has close connections abroad. He, in fact, spends a fair amount of time at Bell Labs. His main area of research is electrochemical processes, and he is active in studying problems of corrosion and oxidation. Yahalom and his group are studying ac anodizing and pulse-plating. In the case of the latter, it appears that millisecond pulsing results in a better plated coating. For example, when silver is pulse-plated, less tarnishing of the product is observed. And when the same technique is employed for cadmium plating of steels, significantly less hydrogen embrittlement effects occur. This is likely due to the pulse time being below any "hydrogen-embrittlement incubation time." Overall, one obtains a better deposit due to less hydrogen bubbling.

Yahalom actually wears two hats at the Technion: in addition to being a member of the academic staff, he runs the Corrosion Laboratory of the Institute. Although most of this work is industrial, a fair proportion is done for the Israeli government. In the latter category, I was shown samples of the most horrible examples of exfoliation corrosion. This was clearly due to poor fabrication methods. The failed pipe was submitted to the Institute for evaluation by Nicaragua, which stood to lose vast sums of money as well as important crops. This trust in Israeli technology by a number of developing countries is exactly what the Institute is attempting to promote.

Another important aspect of the Institute is a program on NDT, supervised by Dr. Shraga Yaron. He and his colleagues have developed an on-line acoustic emission device that follows behind a TIG torch and detects cracking during automatic welding operations. In preliminary tests, the cracks are initiated by copper plugs placed at intervals in stainless steel along the welding track. During solidification, after the torch passes, a stress is developed at the freezing copper plug, and cracks are introduced which emit noises that are detected and analyzed by an array of black boxes. Yaron is convinced that the system has great potential utility, but believes that "the world isn't ready for this yet." The results are interesting, although, like many phenomena in the business of acoustic emission, a bit ambiguous at times. This approach, however, warrants (and is widely receiving) serious attention.

The NDT group provides a considerable standard testing service on short and long term contracts. They have developed and patented a new eddy current device which is both convenient to use and highly sensitive. The technique employs automated empty-coil compensation. J. Baruch, a member of academic staff, is working together with the Institute on the relation of acoustic emission to microstructural changes, especially with reference to using this technique to detect crack formation during welding.

Yaron also directs the welding research at the Institute. This work is staffed by 35 members, and is supported by a considerable annual grant from the Israeli government.

The electron microscopy effort within the Department is under the supervision of Dr. Y. Komen, a former postdoctoral researcher at Cornell.

Komen is deeply involved in studying electronic materials, a strong subject at the Technion. He is studying electromigration in thin films, with an eye on the failure which arises due to high current densities. He is also using electron microscopy to examine the defects introduced in semiconductors due to ion-implantation. A case in point is As implanted in Si, where defects accumulate near p-n junctions, with attendant serious effects.

On a totally different subject, Komen is beginning a study on the details of the interface introduced by explosive cladding. Komen feels that the interface region is not understood sufficiently, so he is looking at a copper single crystal explosively clad onto another copper single crystal. The resulting mess that might be expected does not, in fact, materialize, and Komen--together with co-workers from industry--is examining what they call the "clad-effected zone."

Materials Engineering at the Technion is at a crossroads. Though a graduate program, it carries a large load of undergraduate service courses, for which, generally, I heard few complaints. But they have the same problems which plague all of engineering education everywhere. During my recent visit, I had the pleasure of a long chat with members of the faculty and Prof. Milton Ohring, on sabbatical leave from Stevens Institute of Technology. Ohring has been talking with Minkoff and others about the need to reorganize the curriculum to make it more compatible with the needs of Israeli industry. This the Technion is well suited to do, especially in light of the presence of the Israel Institute of Metals.
(H. Herman)

ONRL REPORTS

See the back of this issue for a list of current abstracts and how to obtain the reports.

MEDICAL SCIENCES

SEVEN SCORE YEARS AND TEN OF MEDICAL HISTORY

More than other years, this seems to be one for the celebration of institutional longevity. The United States Bicentennial is being popularized in London by an exhibit of *tussauderie* (my word) called "Hollywood Cavalcade" in the shop windows of Selfridge's department store, and recognized in more dignified style in a surge of references to Americana in art, science and the professions, ranging from full-blown expositions to the calculated nod of recognition and a hint of genuflexion. On the medical side, for instance, the birth of American neurology is credited to the Civil War in a lecture at the Royal Society of Medicine describing the work of two contemporaries of the great English neurologist Hughlings Jackson: Silas Weir Mitchell and William Alexander Hammond. This takes us back one century; a second equal jump would have landed us with the War of Independence which "made" American medicine.

In the United Kingdom a hundred years ago the Physiological Society was founded, an event about to be celebrated in Cambridge at the ordinary scientific meeting of 2-3 July by special lectures and a big centenary dinner, divided between Trinity, St. Catharine's and King's Colleges. Many foreign guests have been invited.

On the London scene, two notable medical histories have been published recently, their timely appearance prompted, no doubt, by the circumstance that a great flurry of activity in the building of hospitals and medical schools occurred about a century and a half ago under the influence of pressures generated by the industrial revolution. One of the books, *University College Hospital* (UCH) *and its Medical School: A History*, by W.R. Merrington (Heinemann: London 1976) limits itself of necessity to this period, for this famous hospital first opened its doors in 1834. The other takes us back eight hundred and fifty years, although, again, major rebuilding and major medical innovations (and setbacks) occurred within the last century and a half, just as at UCH. The book is called *The Royal Hospital of Saint Bartholomew*, 1123-1973, edited by

Victor Cornelius Medvei and John L. Thornton (The Royal Hospital of St. Bartholomew: London, 1974).

From about 1834 onwards these two great institutions developed in parallel, subjected to the same influences of advancing medical enlightenment and, whenever they might have been about to diverge, being stopped short and, so to speak, shocked back into conformity, by the huge catastrophes of two world wars and a depression. And now they are both--in the words of one writer in the Bart's history--"engulfed in the maelstrom of the National Health Service." They have become "part of a district, of an area, of a region." The words convey a certain despair, echoed in the Foreword to the other book: "I am sad that before the text was complete the Board of Governors of University College Hospital was abolished under the Act which reorganized the National Health Service." An era, it seems, has ended.

I would like to write a bit more about the UCH book. The events recounted took place on familiar ground; I knew a few of the people mentioned and many of the names. I frequently pass by, and still admire, Poore's and Waterhouse's red brick cruciform building opposite University College in Gower Street, which in 1898 represented a novel contribution towards the avoidance of some of the dreadful stinks, contagions and sundry perils that had made hospitals death houses for staff and patients alike. The old buildings had long outlived their usefulness. Twenty years earlier W. Cadge had called hospitals "the nurse of pyaemia", and Sir Eric Erichsen had written that "once a hospital has become incurably pyaemia-stricken, it is impossible to disinfect it by any known means...Just as the cattle plague has to be stamped out by the pole-axe so has the infection of a pyaemic hospital to be destroyed by the pick." Reading this, I was reminded of Rainer Maria Rilke's remark--in *Malte Laurids Brigge*, perhaps--about modern improvements: Now, he said, people have a hundred beds to die in, instead of only 20.

Of course antisepsis made all the difference, though not without a struggle for acceptance. There are in the book many anecdotes about the terrible consequences of accidental infection, the impossibility of abdominal surgery in pre-Listerian days, and the token service given to aseptic practices by people who attributed them to an excess of credulity or, at best, a desire to be in the swing. As late as 1890 one surgeon, omitting the prescribed ten minutes' hand-washing before operating, explained that he "gave them a good wash before leaving home."

Anesthesia preceded asepsis. The first public demonstration of ether anesthesia at the Massachusetts General Hospital, 16 October 1846, was quickly repeated by an American emissary in London, and the first operation under ether in England was done at UCH on 21 December 1846--though not until the surgeon and others had themselves experienced the effect of inhaling the vapor. This precaution they considered necessary because attempts to avoid pain had become associated with a recently discredited claim that remarkable powers of medical diagnosis and prognostication could be called forth by mesmerization. At the end of that first painless operation the surgeon, Robert Liston, is supposed to have said: "This Yankee dodge, Gentlemen, beats mesmerism hollow."

These fundamental but profoundly practical discoveries provided the conditions, now taken for granted, under which most subsequent advances in medical science became possible. Many of these, too numerous even to list here, originated at UCH and its Medical School. Ringer's solution was discovered after Sydney Ringer had noticed that a salt solution made up accidentally "with pipe water supplied by the New River Water Company" had a different effect on the contraction of the ventricle from one made with distilled water. "Classical" experiments on nerve regeneration were done by investigators who severed their own nerves for the purpose. The technique of stereotaxis was invented in order to study the effects of stimulation or oblation of small regions deep in the cerebellum. The functions of the thyroid gland were studied over many years by many people, and the active principle, thyroxine, was eventually synthesized by C.R. Harington. The efficaceousness of mandelic acid as a urinary antiseptic was established. Of topical interest perhaps in this miscellany is the work of Sir Victor Horsley in following up Pasteur's work on immunization against rabies. In the current atmosphere of official apprehension, not to say hysteria,

as rabies advances toward the western limits of the European continent and its offshore islands, it is not always remembered that an outbreak in London in 1886 had led to an epidemic in a herd of deer in Richmond Park; 264 deer died of the disease. Nevertheless, the threat was contained and rabies eliminated from the British Isles by strict muzzling and quarantine regulations. The current situation was described by A. W. Frisch (ESN 28-9:337).

These random remarks do little justice to Merrington's book as a whole. The history of an institution is a weave within which any one of the many threads may at a particular time divide, thicken, attenuate, or coalesce with others. Great skill was needed, and demonstrated, in following first this thread, then that, without losing a sense of chronological development of the whole. Charities; funding campaigns; buildings; organization and proper subject matter of teaching; medicine, surgery, obstetrics, nursing, pharmacy; hospital plus hospital medical school *versus* college premedical school plus university; protecting the interests of the patients in a research hospital; research *versus* clinical practice; private practice *versus* hospital service; salaries; the "special relationship" with Edinburgh; the American influence; the decisive role of strong personalities at critical points; personal collaborations, conflicts, misfortunes; distinctions conferred. All these are sketched with a refreshing lack of pedantry, almost without footnotes, in a cool narrative style which leans heavily upon the biographical, the anecdotal and--as befits an author who has also practiced surgery--the occasional bit of gallows humor. The biographies of the personages who were there in the early days are often sharply drawn in idiosyncratic detail; later, as the place grew and the population multiplied, personalities tended to blur. Under sheer pressure of numbers the biography contracts almost to Who-was-Who dimensions.

There are two points which ought not to be omitted in telling ESN readers about the history of UCH: the unique relationship with the University of London, and the American influence.

The University of London was opened in 1928 without any religious affiliations. This was partly in opposition to Universities such as those of Oxford and Cambridge, which could exclude a student on religious grounds. It had from the first a strong leaning toward medicine because Oxford and Cambridge did not attach much importance to professional training and because "there are local advantages in the Metropolis, for connecting the theoretical with the practical parts of these branches of knowledge..." Indeed, the two inaugural lectures were given by the Professor of Surgery and Physiology and the Professor of the Nature and Treatment of Disease, respectively. The University Dispensary, opened in 1828, gave way to the North London Hospital, later renamed University College Hospital. The development that followed was closely related to the enlargement of the University whereby the original University became only one of the several colleges of the University and was rechristened University College. Another important development was the establishment of a Medical School attached to the Hospital and of departments of pre-medical sciences--Physiology, Anatomy, Pharmacology--within the College. The distinguished history of these UCL departments is referred to only incidentally. Just a few names appear here and there: Bayliss, Starling, Elliot Smith, Verney.

The American influence that everybody will remember was the Rockefeller Foundation grant in 1920 of about a million pounds--staggering at that time--for the building program of the Medical School and the teaching of Anatomy at University College. It is less often recalled that American influence is not wielded exclusively by gifts of money. Several years earlier the irascible Dr. Abraham Flexner had succeeded in disabusing Richard Burdon Haldane (later Lord Haldane) and the Haldane Commission of the home-grown notion that "medical education in Britain is the best in the world." The Commission accepted Flexner's opinion. At the same time, it was Flexner who selected UCH as a fit place for medical research. So we may conclude that the later munificence of the Rockefeller Foundation was no accident.

I have said that these serious matters are much enlivened by anecdotes. It would be unsporting to quote many of them, but the following may fitly conclude this article. The surgeon Christopher Heath (1835-1905) was noted for his speed and accuracy in performing extensive operations. After one such in which he had removed

an enormous tumor, "a young nurse was heard to ask, 'Which part do I take back to bed?'' Mr. Heath's reply is not in the record. (J.B. Bateman)

OCEAN SCIENCES

OCEANOGRAPHY AND METEOROLOGY IN HAMBURG

Hamburg is a city rich in institutions dealing with research in meteorology, oceanography and in the important interfacial region separating these two disciplines namely, the sea-air interface. Most of the money provided in oceanography by the Deutsche Forschungsgemeinschaft (the German NSF) is spent at institutes located in Hamburg and Kiel. It block-funds interdisciplinary research programs over rather long periods of time. Each individual grant is judged on its own merits and is renewable every two years or so.

The Institute of Meteorology and the "Institut für Meereskunde" both are part of the University of Hamburg. Professor L. Hasse heads one of the groups into which the Institute of Meteorology is divided. This group has been involved for a number of years in field measurements (off the Island of Sylt) and studies dealing with the modeling of turbulent boundary layers found in the first few meters above the sea surface. These studies have concentrated over the open seas rather than over land, for at sea, diurnal changes in temperature, moisture, etc. are never as pronounced as the corresponding changes found on land. Theoretical modeling of the prevailing conditions is much simpler. Hasse feels that, for wind speeds below 12 m/sec, theoretical modeling and parametrization of relevant quantities is well in hand and research should now deal with conditions prevailing when the wind speed exceeds this value. In that same Institute, Professor G. Fisher heads another group which deals with theoretical meteorology. Spectral models are being developed and are used to study geostrophic turbulence. General circulation atmospheric models, as well as short range prediction models, also are being developed. These are to provide meteorological input into storm-surge and other ocean models developed at the Institut für Meereskunde.

At the Institut für Meereskunde, a smaller number of scientists are interested in various aspects of numerical modeling of ocean dynamics on a variety of scales. One finds conventional models of a two-layer ocean (Dr. D. Engel) driven by surface stress, in which thermocline dynamics are studied when quasi-stationary atmospheric lows are present; models in which the biological evolution (Dr. G. Radach) is coupled to the dynamics of the ocean; and a model in which a fluid "particle" is followed in its time evolution. This last unconventional model is being developed by Dr. E. Maier-Reimer in an attempt to study the formation of sharp fronts in the estuary of the Elbe river. Dr. K. Koop has set-up a storm-surge model which performed well in the hindcast of last January's severe storm surge which hit most of the coastal areas of Northern Europe. Dr. H. Freidrich is writing on one-dimensional mixed-layer models. Various permutations and arrangements of these models are planned in the future to provide more sophisticated analogs of the "real world." At least that is the hope! Some of these basic building blocks are to be coupled among themselves (effect of biological activity coupled to a one-dimensional mixed-layer model; etc.) or among models developed by meteorologists so as to form an atmosphere-ocean system.

Professor K. Hasselman, who spent several years in the US, now heads the newly formed Max Planck Institute for Meteorology, which although housed at the University of Hamburg, receives its main support from sources not connected with the University. The staff need not have an affiliation or teaching duties with the University and can devote full time to research. The Institute is composed of two groups: the first, a rather small one of four scientists, deals primarily with climate dynamics. Hasselmann believes that, in an atmosphere-ocean system, the atmospheric forcing can be considered as random on the long-time scales which are characteristic of the adjustment time of an ocean; therefore, the ocean acts as an "integrator" and tends to smooth out this random forcing. During my visit, I attended an informal seminar, presented by Dr. C. Frankignoul in which he showed

that some of Hasselman's ideas when applied to a stochastically-forced ocean model could produce large-scale sea-surface temperature anomalies. Hasselmann's ideas on climate are quite original, for they claim that one must seek a stabilizing mechanism to explain present day climates for, if unchecked, the random atmospheric forcing would tend to pull the climate further and further away from the initial climatic state of the model.

The second group, of about 20 people, is partly staffed by scientists who belonged to the recently disestablished Institute for Radio and Marine Meteorology. The primary objective of this group is the study of surface gravity waves at sea. Hasselman summarized their goals as (a) development of numerical models capable of predicting sea state in an efficient, economical way and (b) development of remote sensing techniques which will enable us to gather wind and sea state data from satellite. Active microwave backscatter techniques are being used to determine surface wind and surface wave spectra. This work is being done in collaboration with NASA and NOAA (Miami). Research on surface waves is being carried out as part of two international programs: The Joint North Sea Wave project (JONSWAP) and the North Sea Wave Model (NORSWAM). The reader is referred to a previous article (ESN 29-2:83) where these programs are described in great detail.

Although in the past, German oceanography and meteorology has been somewhat isolated, it now appears to be experiencing an age of growth and of interaction with other scientific communities. This growth is fostered by governmental multi-disciplinary bloc funding of research programs which tie-in with several multinational programs. (A.I. Barcilon)

PHYSICAL SCIENCES

LOW- AND VERY-LOW-TEMPERATURE PHYSICS AND THE UNIVERSITY OF LANCASTER

The University of Lancaster is one of the newer schools in England. While many of the newer British universities are closely coupled to the surrounding community by utilizing the locally available housing and shops, over 50% of Lancaster's 2000 undergraduates and 500 graduate students, and even a large fraction of the teaching staff, reside on campus. The remainder find accommodations in Lancaster, a picturesque town three miles distant complete with castle and ruins of Roman baths, or in the seaside resort of Morecombe. Because of the isolation, the modern University buildings are nestled around a "High Street". This is lined with shops which serve its "village" of 4000 daytime inhabitants, and the residential college dining halls serve as restaurants. In this article I will review the work of the low temperature physics in this setting, as well as the British ultralow temperature physics plans which affect the Lancaster program.

Professor E.R. Dobbs, who became the first Chairman of the Physics Department in 1964 was largely responsible for the development of the strong Low Temperature and Solid State Physics group at Lancaster. A few years ago Dobbs accepted the chairmanship of the Physics Department at Bedford College one of the ten colleges composing the University of London. Dr. M.J. Lea followed Dobbs to Bedford where they have continued their investigation of microwave ultrasonic properties of He^3 at milliKelvin temperatures. Only last year another active member of the Lancaster Department, Dr. D. Dew-Hughes, decided to move his work on superconducting materials to Brookhaven National Laboratory.

Despite these significant losses Lancaster still has a large and active group of low temperature physicists with a strong interest in SQUIDs (ESN 29-2:86). During my visit in May, Dr. G.R. Pickett was completing a six months sabbatical at the H.C. Ørsted Institutet in Copenhagen. Earlier, Pickett, after a few years at Professor Lounasmaa's laboratories in Helsinki, came to Lancaster and put together a dilution refrigerator equipped with sintered copper heat-exchangers, a pumping system and screened room in less than one year. This apparatus has now been used to study hyperfine fields using a SQUID-NMR technique (ESN 29-2:86).

Dr. D. Thoulouse of the Centre de Recherche sur les Tres Basses Temperatures in Grenoble and Pickett are organizing a Europhysics Study Conference on Dilution Refrigeration and its Applications to be held at Lancaster next September.

Two students of A. Guénault have just completed their research theses. One, C.M. Pegram, investigated the idea of Garland and Van Harlingen that

magnetic flux would be thermally generated in a superconducting loop formed from two different superconductors (see *Phys. Letters* 474, 423 (1974). The approach was to use niobium and tantalum and an RF SQUID for the flux determination. The preliminary results of this difficult experiment were reported at the Helsinki Low Temperature Conference, LT 14. Pegram found the suggested phenomenon, but its magnitude was somewhat larger than expected. The other student, R.H. Dee, investigated the transport properties of the intermediate state of indium. Measurements of the electrical and thermal resistances and the thermoelectric power were made with the low-pass filter SQUID technique described in a previous ESN article (ESN 29-2:86). This experiment is rendered difficult by the temperature-dependent sample magnetization. Nevertheless the measurements permit for the first time a direct separation of the phonon drag and the electron components in the thermopower.

Dr. P.V.E. McClintock has been responsible for a very active program involving field-emitted electrons in superfluid helium. With D.R. Allum, he has studied the drift velocity of negative ions for temperatures above 0.45 K and electric fields, E, from 26 to 200 kV/cm and finds that it varies linearly with $E^{1/3}$, rather than the expected $E^{2/3}$ above the Landau critical velocity. In these experiments, which appear to be possible only for pressures above about 20 atms, measurements made at 25 atms suggest that ions traveling faster than the critical velocity emit rotons in pairs rather than singly (which would have given the expected $E^{2/3}$ dependence). Reasons for such a selection rule are unknown.

In a second experiment the V of negative ions at 25 atms near 1 K for E up to 17 kV/cm were measured. Here there appear to be two critical E's, the first of which, E_{c1}, marks a sharp decrease in V due to the trapping of the ion on a vortex. McClintock identifies the second, E_{c2}, as the thermally activated field-assisted escape of the ion from the vortex rings. Similar characteristics occur for the positive ion as shown by L. Bruschi, P. Mazzoldi and M. Santini (*Phys. Rev. Lett.* 21, 1732 (1968)), who interpreted their results in the same way. It appears that confirming results for the negative ion have also been obtained by Dr. J.D.P. van Dijk at the Kamerlingh Onnes Laboratory, University of Leiden. McClintock feels these experiments, which will probably be reported soon in *Physical Review Letters*, depend crucially on the low He^3-content of their He^4 samples. McClintock, Pickett and a student hoped to extend these ion studies using a He^3 dilution refrigerator.

There are two other members of the Lancaster Department interested in experimental low temperature physics, Drs. D.J. Meredith and K. Wigmore. Their work is concerned with high frequency phonon properties of crystalline materials, especially superconductors, metals and impurity states in dielectrics. At the August Nottingham Phonon Conference, Wigmore reported using the heat-pulse technique with parameters of applied stress, applied magnetic field and crystal orientation from 1.3-4.2 K to attempt to derive a detailed model of the dynamic Jahn-Teller effect for Cr^{2+} in MgO (*Phonon Scattering in Solids*, Ed. L.J. Challis *et al.* Plenum Press, New York, (1976), p. 187). Meredith, while recently in Amsterdam, was involved in de Haas-van Alphen measurements utilizing a novel technique employing a flux gate magnetometer coupled with a superconducting flux transformer. (See *Low Temperature Physics* Lt14, Ed. M. Krusius and M. Vuorio, American Elsevier, New York. Vol. 4, p. 286.) Meredith is becoming interested in transverse zero sound in superfluid He^3 and is continuing his work on superconducting devices.

There is also some theoretical interest in low temperature phenomena at Lancaster. I spoke with Dr. I. Bolton, a postdoctoral appointee, who has been working on the characteristics of transverse zero sound in both phases of superfluid He^3. Dr. P. Lee has similar interests. Dr. R. Watts-Tobin is involved with the non-equilibrium properties of superconductors.

Lancaster is one of four English universities with serious interests in research on helium below 10 mK. The present situation is that the Science Research Council (SRC) funded the University of Sussex group, Professor D. Brewer et al., about a year ago to investigate the thermodynamic properties of liquid He^3 in the mK regime. The approach was to use the Pomeranchuck effect (cooling of material by adiabatic compression along a melting curve of negative slope) in a system with a high surface-to-volume ratio, and realized by a cell filled with a glass matrix of high porosity Vycor. Due to van der Waals attraction by the glass surface, a large fraction of

the He^3 surface atoms, mostly those in the second atomic layer, are effectively at a pressure of about 10 atm. An applied external pressure of about half or two-thirds of the bulk melting pressure causes a reasonably large fraction of the He^3 surface atoms to be on the melting curve. Thus, upon adiabatic compression, the surface atoms are cooled by the Pomeranchuck effect and the bulk liquid He^3 atoms are cooled through thermal conductivity in the He^3 itself with no Kapitza boundary resistances to bottleneck the cooling rate. Some preliminary success was reported last summer at the Fourteenth International Conference on Low Temperature Physics, LT14, in Helsinki. Near the first of this year the SRC awarded a £ 70,000 grant to the University of Manchester group, Professor H.E. Hall *et al.*, to investigate the hydrodynamic properties of He^3 below 10 mK. Construction of a nuclear adiabatic demagnetization cryostat incorporating a He^3 dilution stage, screened room and vibration-filtering cryostat mount are already under construction at Manchester. The SRC suggested the collaboration of the Lancaster group with the Manchester group and the fourth group, Professor E.R. Dobbs *et al.* at Bedford College, with Sussex University. Though the SRC suggestion is reasonable in principle, Lancaster is an hour from Manchester and Bedford an hour from Sussex, which will inhibit close collaboration.

Pickett, Guénault, and McClintock have joined forces to actively pursue mK physics by building up their own laboratory. They have submitted a new SRC proposal which they feel has a good chance of being funded this coming year. They also hope to continue their collaboration with Manchester. At Lancaster a large screened-room is nearly complete and a 36-ton vibration-filtering cryostat mount is under construction. Because of the Lancaster group's industry and expertise with SQUIDs, they should prove invaluable in the Manchester collaboration, and I feel that it is very likely that they will eventually have a nuclear cooling cryostat of their own.
(T.A. Kitchens)

ULTRALOW TEMPERATURE PHYSICS AT GRENOBLE

In a companion ESN article (p. 307), I mentioned that I attended the session on "Refrigeration Below 1 K" and a special session on "Dilution Refrigeration" at the International Cryogenics Engineering Conference (ICEC6) held in Grenoble in May. I also visited le Centre de Recherches sur les Très Basses Température (CRTBT) one of the Centre National de la Recherches Scientifique (CNRS) laboratories in Grenoble. In this article I will recount some of the highlights of these experiences.

The ICEC6 session on "Refrigeration Below 1 K" contained seven papers, three of which were not involved with dilution refrigeration. Professor J. M. Goldschvartz and his collaborators (Delft University of Technology) described an activated charcoal adsorption-pumped (Professor Kurti suggested calling these "adsorpumped") down to 0.5 K with cooled He^4 volumes of 250 cm^3. They also described a superfluid-tight-valve--utilizing a ruby sphere, a capacitance helium-level indicator and a superfluid-tight indium seal arrangement which was used in this cryostat. H.D. Denner (Fritz-Haber-Institut, West Berlin) described a rather elaborate recirculating-He^3 cryostat capable of maintaining a constant temperature below 1 K for periods up to a week. The novel feature of this cryostat was that it does not have a 4.2 K helium bath, only a HeII stage. This is replenished by filling a small volume with 4.2 K helium, pumping it down to the HeII stage temperature at which point it is automatically admitted through a superfilter into the HeII stage. The third presentation was given by G. Chanin (CNRS, Verrières-le-Buisson) on a portable He^3 "adsorpumped" cryostat suitable for balloon-, aircraft-, or laboratory-cooling of infrared detectors. This cryostat, which had an operation time limited by the eight-hour He^4-bath lifetime, was quite similar to one developed for the same purpose at the University of Oregon several years ago.

The remainder of the session concerned dilution refrigeration and much of the same work was discussed in more detail during the special session. P. Roubeau (CEA, Saclay) described a dilution refrigerator for neutron experiments with easy sample access. The dilution stage with the sample is situated in the dilute phase in the mixing chamber and can be removed quickly from the top of the cryostat. For a He^3 flow rate of 0.3 mmol/sec, 100 (200) ergs/sec sample heating can be extracted and the sample maintained at 50 (55) mK. The adsorption of 4-Å neutrons, due to the dilute He^3 liquid,

was held to 10% in Roubeau's design.

T. O. Niinikoski presented some performance characteristics of his dilution refrigerator at the Centre Etude Recherches Nucléare, Geneva, which is capable of continuously maintaining 14 mK and He^3 through-puts as high as 20 mmol/sec. In this session and also in the special session, Niinikoski presented his analysis of dilution refrigeration. He finds that the refrigerator parameters such as the minimal exchanger areas, connecting capillary diameters, etc., can be determined from some simple equations involving the optional He^3 flow rate, the required heat extraction rate, and some Kapitza resistance data which he provided for various documented heat exchanger designs.

A. Th. A. M. de Waele reported on the He^3 circulating dilution refrigerator with multiple heat exchangers developed at Eindhoven University of Technology. This approach is not very useful unless ultimate temperatures less than 20 mK are desired. But this approach has the disadvantage that the small volumes in the mixing chambers must make it difficult to establish the correct He^3-He^4 charge and flow rates. At the time of the conference they had built single, dual, and triple mixing chamber refrigerators with terminal continuous temperatures of 13 mK, 5.7 mK and 4 mK, respectively. De Waele estimates that 2 mK is the minimum continuous temperature obtainable in this manner for reasonable configurations.

The final talk was given by G. Frossati on the new continuous heat exchangers developed at CRTBT which utilize sintered silver powder on a silver foil separating the two counterflows. Using only one of these exchangers--and no capillary counter-flow exchanger--he has obtained a terminal temperature near 16 mK at a circulation rate of 100 μ mol/sec in a refrigerator using a still which produces only 1% He^4. Frossati has analyzed the performance of his refrigerators and finds a component of the heat-leak which is proportional to the circulation rate, not the square of the circulation rate as expected for viscous heating, which is in disagreement with Minikoski's ideas. This difference created a long discussion among the attendees of the special session, even so the question was not clearly resolved.

The afternoon visit to the CNRS laboratories in Grenoble was very interesting. We toured the high magnetic field laboratories which are only a few years old. The facilities include a 10 MW supply and Bitter solenoids of various configurations, with the maximum field configuration providing a continuous 20T. The operation and research program of these laboratories is very reminiscent of the Francis Bitter National Magnetic Laboratory at MIT. The projects involve the electronic, infrared, and optical properties of materials, especially semiconductors, at high fields. Magnetic bubbles and spin-flip lasers, tunable with magnetic field, are also receiving attention. Several superconducting magnets with core fields in excess of 12.5 T are operational, and a hybrid magnet to produce over 20T in the steady state is being constructed. As I understand it, the normal currents will be in the copper used to stabilize the superconducting circuit in this magnet.

Many of the projects in the magnet laboratories are being pursued in collaboration with the Max-Planck-Institut in Stuttgart which provides matching funds with CNRS. Apparently this binational funding is quite a stable arrangement.

In the older laboratories of the CRTBT, I viewed the mockup cryostat of a 500-kW superconducting alternator which will operate at 3000 rpm and require 10 liters/hr of liquid helium for cooling. A paper at ICEC6 by Y. Brunet, G. Faure Brac, P. Glanese and C. Pinet described this apparatus and the thermometry circuits which were telemetered out from the rotating cryostat. In these laboratories there were two dilution refrigerators; one being used routinely for studies of the magnetic and transport properties of metallic alloys, while the other utilizes eight heat exchangers of an older epoxy design to reach 3.5 mK continuously. One interesting feature of the CRTBT dilution refrigerators is that they use PVC tubing for the capillary connectors both the He^3- and the He^4-rich streams. The PVC tubing is merely force-fitted onto metallic fittings and differential thermal contraction apparently makes these connections superfluid tight.

In the new building of the CRTBT there is truly an impressive sight. Two large dilution refrigerators and an older adiabatic demagnetization cryostat are in operation, and four

more dilution-refrigerator stations are under construction, one or two of which will be used by the Max-Planck-Institut. And there is room--and plans --for more! One of the operational dilution refrigerators uses the older epoxy heat-exchangers to obtain 6 mK and is being used to study the specific heat of He^3 as a function of temperature and pressure. The second operational cryostat has the one sintered-silver continuous heat-exchanger described above. This cryostat will soon be modified to have several of these new heat-exchangers, a nuclear adiabatic demagnetization cooler and a superconducting quantum interference device. It will be used to investigate the superfluid phases of He^3. Drs. Fossati, Tholouse, and the other CRTBT staff form an enthusiastic and energetic team that will undoubtedly make even more of an impression on low-temperature physics in the very near future. (T.A. Kitchens)

PSYCHOLOGICAL SCIENCES

BIOMECHANICS AND VISION AT LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

The Department of Human Sciences at Loughborough University of Technology is one of the most active and productive in the UK. While ergonomics is probably their forte, degree programs also are offered in human biology and psychology. A description of the Department and several of its programs is contained in a companion article (see p. 332). This article will address primarily those research programs related to biomechanics and visual processes.

In 1971, while a graduate student, Mr. D.L. Mitchelson began a program designed to develop instrumentation for making on-line recordings of the angular displacement, velocity and acceleration of limbs and body segments. The reason for this interest was to make it possible to analyze limb and body movements in relation to work skills; design improved orthotic devices; assess the progress of physiotherapy; evaluate the results of orthopedic surgery, and obtain data on body movements for a variety of other purposes. The instrumentation which resulted is referred to as CODA (Cartesian Optoelectronic Dynamic Anthropometer) which in effect is a polarized light goniometer.

The system works as follows: Light emitted from a dc source is polarized by transmission through a disc containing a linearly polarizing filter. The disc is made to rotate in excess of 125 revolutions/sec. The light is received by a transducer which consists of a pair of matched photocells in front of which are mounted polarizing filters with planes of polarization fixed at 90° to each other. The outputs from the two photocells are connected in opposition, consequently any non-polarized light incident on the transducers is rejected. The signal produced by the polarized light, whose plane of polarization is rotating, is sinusoidal and of a frequency twice that of the revolution rate of the disc.

Photocell transducers may be mounted on any of the relevant limb and body segments of the subjects under study to produce simultaneous angular displacement, velocity and acceleration outputs, i.e., as the limb moves, the *mounted photocells* move, altering the output of the photocells because of the change in plane of polarization. Mitchelson demonstrated this technique during my visit. In this case a subject had two pairs of photocells mounted on his right leg, one below the knee and the other above. The subject walked on a treadmill in front of the rotating polarized source (daylight has no effect on the recordings) at a distance of about six feet. A graph showing a continuous recording of the angular movement of the leg was produced in real-time on an analog display, and on demand could instantly be reproduced on hard copy. The instrumentation, which is easily portable and appears to be easy to use, has been packaged in cooperation with a local electronics firm and will soon be available commercially.

The system is being modified to permit three-dimensional recordings of body movements. In the new system the photocell transducers worn by the subject will be replaced by miniature gallium arsenide injection lasers which emit short pulses of infrared light. Circuitry is required (worn by the subject in a light-weight battery pack) to provide the lasers with the short high-current pulses which stimulate the emission of light. Three electronic cameras are used to detect the output of the lasers worn by the subject. The output of two of these cameras is used to determine the position of the

lasers in the X and Y planes. The third camera is placed centrally between the other two and is sensitive to vertical movement only. The outputs of the cameras so-produced are proportional to the true XYZ coordinates of the lasers and do not contain errors equivalent to the parallax errors which occur in conventional photographic recording. This system will permit the recording of 360° turns and similar movements without the subject getting entangled in a mesh of wires, as would be the case if the lasers were attached to stationary equipment. This program is a beautiful example of an idea developed in an academic environment being carried through to fruition, including the marketing of a commercial device that could be a major contribution to the treatment of patients handicapped by injury or surgery, improved design of orthotic and prosthetic devices, athletes wishing to increase their efficiency through the analysis of body movement, and to scientists wishing to conduct dynamic anthropometrical studies.

Two other programs are underway which relate to physical anthropometry. The first is under the direction of Dr. P.R.M. Jones who divides his interests into three areas. The first is a long-range study in which work-capacity of both children and adults is being correlated with ethnic differences. Jones is measuring O_2 uptake to determine the ability of specific muscles to do work. He also is attempting to measure muscle mass using a variety of techniques including radiographs, ultrasound, body densitometry and by measuring the level of potassium 40. He hopes to relate these findings to bone cortical thickness and differences in body composition.

In a second area, Jones is attempting to relate the maturational development of the spine in the human fetus to fetal movement. In a joint program with the University of Manchester, he plans to stimulate movement in animal fetuses and to administer various drugs to the mother and measure the effect that such intrusions have on spinal development. Jones' third area of interest is a study in collaboration with the University of Leicester in which an attempt is being made to identify specific heart signatures in individuals so that early signs of heart disease can be identified using a computer.

To round out what, in the writer's opinion, is a fascinating program in physical anthropometry is a study under the direction of Dr. J. Altha which concerns the influence of heart movement on postural movements. In addition, Altha is experimenting with various types of knee prosthetic devices with the objective of developing one with full freedom of movement. Altha is using the polarized-light goniometer described earlier as a means of determining the efficacy of the prosthesis.

Another active group at Loughborough is the Biodynamics and Vibration Research Group. I had the opportunity to talk with Mr. J. Sandover who, over the past few years, has been responsible for an extensive program designed to measure the effects of mechanical vibration on human performance, comfort and health, especially in the area of transportation. A study currently underway involves laboratory simulation and real-world measurement of the effect of vibration on truckdriver fatigue, general condition, and work-rest cycles. In addition to vibration, measures are being obtained relating to cab temperature, noise levels, and seat comfort. Several parameters are being examined including heart rate, body temperature, day vs night shifts, etc. The Biodynamics Laboratory is well equipped to do this work and contains vibrators capable of producing vertical movements of up to $\pm$ 12 cm per stroke, a vertical impact device capable of accelerating up to 100 m/s^2, and extensive instrumentation and computer support equipment.

Under the direction of Mr. P.T. Stone the Vision and Lighting Research Group has conducted a wide variety of studies primarily concerned with the effects of light on various human functions including perceptual responses, performance characteristics, attitudes, and physiological and biochemical responses. A long-term study recently completed was designed to determine the effects of high intensity light (capable of producing discomfort glare) on performance. Size of critical detail resolvable, and contrast required, were among the variables measured. The relationship between age and sensitivity to discomfort glare was also studied. It was found that visual performance generally is unaffected by discomfort glare, at least within the bounds of the parameters measured. Throughout the glare studies, the

light levels varied over a range of 1000 to 11,000 lux. A visual study currently underway is concerned with the controversial issue of whether to put windows in buildings. Although most people feel that windows are necessary they are always hard-put to give tangible reasons. Interestingly, this research is being sponsored by the Glass-in-Buildings Committee of the European Glass Manufacturers Association.

Another study of some interest is being conducted by Messrs. M.A. Sinclair and A. Gale. These investigators are recording and analyzing eye-movement patterns of female lace inspectors in a local lace factory. These mature ladies have the difficult and tedious task of detecting mistakes in machine-produced lace tablecloths, napkins, etc. They are capable of finding 30 to 40% of individual missing threads and imperfections in patterns, working for hours on end. Sinclair and Gale are utilizing an eye-movement apparatus that permits them to record the visual scanning patterns of these fine ladies under normal working conditions. They mount a mirror on the edge of work table such that the image of the eyes is reflected into an eye-movement recording camera, hence to a video tape record/computer combination such that the scanning patterns (utilizing the corneal reflex) are displayed in real time. While the inspection of lace, in itself, may not be pertinent to other specific tasks, the recording techniques are of interest.

A final area of interest is the Aviation Ergonomics Center which has been under the direction of Dr. Elwyn Edwards since its inception in April 1974. (Edwards is leaving Loughborough and will be taking a post at the University of Aston beginning in July 1976.) One of the major studies undertaken by this group has involved the study of pilot activity on the flight-deck of the Trident aircraft (BAC-111). By using trained observers, an extensive amount of data was collected over a period of years during actual flight. These data are summarized in a series of reports obtainable from the University. It is Edwards' opinion that, generally speaking, cockpits are layed out better now than in the past, but that this and further improvements still depend on a few key people and personal interaction rather than the existence of an organized ergonomics effort. Most of the time the first big customers purchasing a new aircraft dictate the layout, and the smaller customers are almost obligated to follow suit due to the expense of making changes. This can be countered to some extent if a group of customers get together and request certain changes.

In summary, there are many projects underway in the Human Sciences Department which, in the writer's opinion, represent a good balance between basic and applied research. There appears to be a continuing relationship between the research staff and representatives of local industry which should go far in maintaining the viability of a dynamic program of research and training. (J.W. Miller)

HUMAN SCIENCES AT THE LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

The Loughborough University of Technology is one of a new generation of British Universities. It is located on a beautiful 140-acre campus on the edge of Charnwood Forest near the cities of Leicester and Nottingham. Over 90% of the University's 3500 students are in residence. Although the University was founded fairly recently, its origins date back about 60 years to, what was then, Loughborough College.

The development and general areas of interest of the Human Sciences Department will be described in this article, while a companion article will contain details of individual research programs.

The ancestor of the Department of Human Sciences was the Department of Ergonomics and Cybernetics which was established in the Loughborough College of Technology in September 1960 with the appointment of Dr. W.F. Floyd, as Head of the Department. It was set up as a postgraduate Department to carry out research in the fields of ergonomics and cybernetics. The College, one of ten designated "Colleges of Advanced Technology," came under the control of the Ministry of Education. It was an unprecedented step under the Ministry for a new Department to be created in any college without an existing teaching requirement.

The first postgraduate course began in January 1961. The program continued to expand, and in September 1964 the first courses in ergonomics and cybernetics were offered to 16

undergraduate students. From the beginning, the Department has sought to link its activities with industry, government and everyday human activities. While basic research programs represented a significant effort, there continued to be an emphasis on the application of the human sciences to real-world problems. The degree program which evolved during the 1960's included mathematics, statistics, physiology, computer-programming, etc., for the first two years with more specialized courses being offered the third and fourth years. A significant portion of the third year was devoted to a project in which the student applied the knowledge acquired the first two years.

In 1970 the Department of Human Sciences was formed. This Department now offers undergraduate honours-degree courses in ergonomics, human biology, and psychology as well as postgraduate degree courses in ergonomics and human biology. The Department is under the direction of Professor Brian Shackel who assumed this post at the end of 1971. Although ergonomics, as a specialty, has existed for over 25 years, formal university degree programs have existed for a relatively short time. The research commitments of the staff at Loughborough and the close liaison they maintain with industry, medical and para-medical organizations, charitable foundations, and with the community at large, are considered to be of vital importance in maintaining a challenging undergraduate program.

The Department has a full-time staff of 21, which is augmented, on a part-time basis, by four Research Fellows, 10 members of the research staff of the University, and 14 members of the Institute for Consumer Ergonomics Ltd. The principal groups in the Department are: Human Sciences and Advanced Technology (HUSAT), Vision and Lighting Research, Biodynamics and Vibration Research; Design Ergonomics Center; Institute for Consumer Ergonomics Limited; and the Aviation Ergonomics Center.

Only the work in the HUSAT group will be described in this article. The research in the other groups will be described in the companion article mentioned earlier.

HUSAT was established in August 1970 to conduct research and to apply the concepts and methods of advanced technology in the human sciences.

At present the HUSAT group has about nine full-time staff members plus several research students. The staff is interdisciplinary in nature and represents such areas as ergonomics, experimental and social psychology, computer science, and engineering. Research and applications work is split about 50/50. Research support comes from the Social Science Research Council and other government organizations while the applications support comes from industrial or commercial organizations. An interesting point concerning support was raised during discussions with various members of the staff. Unlike the US where the researcher frequently has to explain potential applications of his work in order to obtain support, in the UK (at least in the social sciences) it is more difficult to obtain support for work of an applied nature. According to those with whom I spoke, this is because the proposal-review committees are composed primarily of traditional academic individuals who view the proposals of an applied nature as a deviation from the traditional university research role.

A major area of interest in HUSAT is man-computer interaction. This program primarily is under the direction of Mr. K.D. Eason and involves the investigation of problems which arise when computers are first introduced to users such as managers, engineers, clerks or designers. The objective is to improve the capability to predict human behavior in circumstances involving man-computer interaction, by studying the influence of such parameters as response time, the availability of graphical facilities, different hardware and software input devices, along with such factors as personality, experience, and training. For example, the purpose of one such study was to improve system performance and human satisfaction by specifying displays to match more precisely the capabilities and limitations of human controllers. The results showed that the use of probabilistic predictive computer displays gave significant improvement in system performance in a stochastic multistage decision system. The flexibility of the Department's PDP-12A computer is being steadily increased by adding peripheral equipment in order to support these studies further.

In a similar vein, studies are underway to determine the reasons why users, such as managers, when

offered a range of facilities by a system, make use of only a small number of those available. In an effort to improve this situation a program, supported by a computer manufacturer, is being conducted for the purpose of redesigning computer-related equipment in order to facilitate its use. Other related studies include one being conducted jointly with the Tavistock Institute of Human Relations (London) to investigate the role of the on-line computer in branch-banking, and a cooperative program with Denmark, Austria and West Germany in which the uses of computers in different countries are being compared.

A second major area of interest within the HUSAT group is concerned with the changing role of the human from a controller to a system monitor or supervisor. This was the primary subject of a recent five-day symposium (see ESN 30-6:252) and has been a matter of increasing interest to psychologists throughout the world. The particular interests at Loughborough include the study of system monitoring, e.g., scheduling tasks, process control, and air traffic control as well as the behavior of controllers in a simulated chemical plant, parcel-sorting in the Post Office, and controller behavior in nuclear power stations.

Another area of interest is the application of modern technology to the design of office systems with particular emphasis on the storage, retrieval and communication of information. An additional investigation is devoted to studying man-computer interaction related to the design and monitoring of experiments. In this regard, two data-collection devices have been developed. One is a multiple-activity recording system developed as a general purpose data-collection device, while the other is a device for questionnaire answering by push-buttons. Both devices collect data in computer-compatible form in order to eliminate time-consuming data coding.

In summary, HUSAT is a busy dynamic department concerned with the problems of introducing computer technology not only to students but also to local organizations as well as filling in the gaps in our knowledge relating to the interaction between man and machine. Both the faculty and the students are interesting, exciting and doing things. (J.W. Miller)

SPACE SCIENCES

BALLOON RESEARCH

From 2-7 May 1976 the European Space Agency, ESA, sponsored a symposium on sounding rocket and balloon research in the auroral zone. The symposium was held in Schloss Elmau, which is an isolated resort hotel of the classic tradition located right at the base of the Bavarian mountains. While the slide projection and other special facilities were minimal, the isolation and quiet atmosphere was most conducive both to good working sessions and to many personal interchanges between the approximately 100 attendees.

The purpose of the symposium was to provide a forum at which the various current and future European national programs could be described both for information and so that coordinated and complementary efforts could be planned. In this regard it should be noted that since 1972 ESA has funded neither balloon nor sounding rocket work, but it has taken a leading role in providing a legal framework for coordinating the national programs in these areas. This note will review only the items related to balloon programs that were discussed at this symposium. A separate ESN note will review the portions of the symposium related to sounding rockets. This split is felt appropriate in view of the relative independence of the two programs and the growing importance and organization of balloon programs.

France has the largest of the European balloon programs. As described by A. Soubrier (Centre National d'Etudes Scientifique), it was started in 1962, and over the last five years has averaged about 100 zero-pressure (vented and of variable volume) balloon flights per year. Of these about 23% have been for astronomy, 30% for magnetospheric studies, 13% biological experiments, 21% for aeronomy, 7% for meteorology, and 6% for earth observations. The earth-observation work is now increasing. This includes a wide range of earth applications, e.g., agronomy, hydrology, oceanography, and geology, with both film and multispectral photometric systems being used.

Within France there is both a winter- and a summer-launch site so that the prevailing winds can be used to maximize flight times, up to ten hours, without overflying neighboring countries. Also, safety restrictions limit the maximum scientific balloon payload to 350 kg. To achieve longer flights, heavier payloads, or conduct observations at other latitudes, they usually have one or two balloon launching campaigns per year outside France. Recently, these have included campaigns in Antarctica, Brazil, Iceland, Sweden and the USSR. Next year, it is expected there will be a campaign entailing the launching of about 15 astronomy balloons from Brazil, and the following year a cooperative campaign with the USSR conducting launchings from Sweden. The balloons they use are made in France and were initially tetrahedral in shape and up to 3 million ft^3. However, because of the requirements for higher altitudes and payload weights, they are now all spherical and 12 million ft^3.

In addition to their zero-pressure balloon program, the French have experimented with balloons on tethers of up to 18 km in length and have an active super-pressure (unvented and of constant volume) balloon program. In the latter program they flew 500 such balloons from Argentina that had active lives of about three months. These were tracked by the US NIMBUS satellite and were used to study equatorial winds at the 200-mb level. Another 600 such balloons will be launched in 1979 as part of the Global Atmospheric Research Project, GARP, and will be tracked with the US Tiros-N satellites. The French have also launched about 130 such balloons for other scientific studies at pressure altitudes of 50 to 900 mb. For the flights at altitudes near the earth's surface, they have had the problem of rain or dew bringing the balloon down to the surface. To circumvent this problem they have recently tested a super-pressure balloon system to track monsoons in the Indian Ocean in which all the instrumentation is housed within the balloon. Thus, when the balloon is forced down, the instrumentation is not damaged, and the balloon can continue its journey after it has been dried by the sun.

The Transatlantic Balloon Facility, the major balloon system being developed by the UK, was described by J. Delury of the Appleton Laboratory, (previously described in ESN 29-12:555). Cooperating in supporting the program are Italy, Spain, and the US. There will be three flights this summer from Sicily to the US with one payload coming from the UK, and containing gamma-ray burst and x-ray experiments. Another, from Italy, will contain gamma-ray, x-ray and cosmic microwave experiments. The third will have experiments from France, Germany, and Italy and carry x-ray, neutron, and biological experiments.

As another part of the UK program, J. How (Marconi Space and Defense Systems Company) reported on the development of a general purpose balloon platform for use in astronomy experiments. This system will be flown in 1976 and is designed so that it can point a 500-kg instrument for at least 20 hours. Star sensors are used for fine pointings and offsets of up to 5° are possible with less than two arc-minutes bias and 10-arc second jitter.

In Germany, K. Schmidt (DFVLR) reported that the DFVLR mobile-rocket-launching organization plans to increase its support of balloon operations as the number of scientific sounding rockets decreases. This past year they started such balloon work by supporting a campaign in Spain with 140 thousand ft^3 balloons to study the winter anomaly. They have scheduled a campaign with three million ft^3 balloons to study atmospheric trace constituents and in the longer term plan five to ten million ft^3 balloon flights to take pictures of the earth's airglow with all-sky cameras that employ television systems as the sensing instrument. The balloons and launch services will be bought from France or the US. In addition, German experimenters will continue to use US launch facilities. For one such program, H. Meier (Dornier Company) described a balloon gondola they have developed that is capable of accurately pointing instruments at the sun. By using solar sensors and a rate-integrating gyro, they have achieved attitude stabilities of better than 0.3 arc-seconds. Their other balloon programs include experiments in infrared astronomy, high-energy astrophysics and atmospheric trace constituents.

Finally, Norway has built a balloon payload to provide data to contribute to the International

Magnetospheric Survey. This payload, described by J. Stadsnes (University of Bergen) consists of two crossed VLF wire antennas that are applied onto the balloon itself, an infrasound detector, a magnetometer, and both omnidirectional and directional x-ray detectors. One such payload was flown last year, and additional flights are planned for both this and next summer.

While this note has reported on the balloon programs described at this particular symposium, it is far from being an exhaustive survey of all the balloon activities in process (for example, see ESN 30-1:1). This is particularly true in the case of balloon-pointing platforms where a number of others have been developed. In fact, it was the diversity of this activity and its growing size that led both Germany and the UK to initiate surveys of all the balloon activities in process in their countries. At this Symposium a balloon working-group was formed, and it is likely that they will formally recommend that ESA initiate a survey of all European balloon-system capabilities (gondolas, balloons, data handling, altitude control, etc.) that have already been developed. Perhaps of even greater importance, it will probably also recommend that ESA put balloon programs essentially on a par with sounding-rocket programs and initiate in the immediate future a study of the future role balloons should play in the European space research program. (L.H. Meredith)

PROJECT HELIOS

Project Helios is a cooperative effort between Germany and the US to study phenomena in interplanetary space from the sun out to 1 AU, the orbit of the earth. To conduct these studies, the project built, launched, and is now operating two 375-kg spacecraft whose orbits repeatedly carry them from 1 AU all the way into 0.3 AU from the sun. At closest approach to the sun the spacecraft are heated by over 11 times the amount of solar radiation as when they are at 1 AU. The requirement that all the spacecraft systems operate properly in this extreme environment was the primary technological problem of the project, and it was successfully solved on both flights. The first of these was launched in December 1974 and the second in January 1976 on Titan launch vehicles.

That the solution of the technological problems was not easy is evidenced by the total project cost of about \$280 M, of which Germany provided about two-thirds and the US about one-third. In line with their proportion of total project costs, seven of the experiments carried on each flight were provided by Germany and three by the US. These experiments measured magnetic fields from zero to 1 kHz, electric fields from zero to 3 MHz, ions from zero to 1 GeV/nucleon, electrons from zero to 5 MeV, interplanetary dust particles larger than 10^{-16}g, and the zodiacal light. They provide a very comprehensive and integrated set of experiments to study the interplanetary medium. A much simpler set of such experiments was flown on the US Mariner-J mission to Mercury. While this mission only went to within 0.44 AU of the sun, its launching prior to Helios in November 1973 took some of the exploratory luster away from the previously planned Helios project.

From 19 to 21 May 1976 Project Helios held a seminar near Bonn, Germany to make the first open release of its scientific results. The general format called for the summarization (by a review paper) of the current status of the knowledge in each applicable subject area. Specifically, there were review talks in the areas of the interplanetary plasma (H. Rosenbauer, MPI Extraterrestrische Physik), interplanetary fields (F. Neubauer, TU Braunschweig), cosmic rays (W. Axford, MPI Aeronomie), and interplanetary dust (J. Dohnanyi, MPI Kernphysik). Each review was followed by a session in which the Helios experimenters in that area presented the results they had obtained. Since a press conference was scheduled to follow the seminar, the individual sessions were conducted reasonably informally with the opportunity for questions and discussion.

In this short note it is not possible to report on all the results that were presented. Rather, some general observations will be given and then some highlights of the meetings outlined. Perhaps the most important general comment is that all the experiments on both satellites, as well as the satellites themselves, are operating nearly normally and their continued operation for the

foreseeable future is anticipated. Secondly, it is clear that most of the analyses of the Helios data will require correlations with data taken on satellites in other positions in the solar system in order to separate temporal from spatial effects. As the final general comment, project data processing problems have meant that the experimenters have only had appreciable data from the first mission in final form since early 1976. Coupled with the launch of the second Helios in this same period, the detailed data analysis is really just starting.

Turning now to the meeting highlights. Perhaps the most interesting result reported in the interplanetary plasma area was what appears to be a strong solar latitude effect in the solar wind. For example, it was observed (R. Schwenn, MPI Extraterrestrische Physik) that Helios' high speed solar wind proton-stream measurements correlated well with similar measurements from other satellites such as IMP when the two satellites were at similar solar latitudes relative to the ecliptic plane. However, when one Helios satellite moved to other solar latitudes, up to 12° different than that of the US IMP satellites or the other Helios, the correlation of the stream measurements was poor. This finding may give added support to the present European Space Agency (ESA) study of a mission to fly a satellite far out of the ecliptic plane. Other interesting results in the plasma area (H. Rosenbauer) include the finding of a sharp "beam" of a few hundred electron-volt electrons coming out from the sun along the magnetic field. This is in addition to the isotropic "halo" and the "core" electron distributions found from the VELA satellites. It might, in fact, be that it is the scattering of these "beam" electrons which produces the "halo" distribution. The plasma results also have provided a measurement of the interplanetary potential relative to infinity as being 85 eV at 0.3 AU and falling to 40 eV at 1 AU.

The most interesting interplanetary field results were from the low frequency electric field measurements (D. Gurnett, University of Iowa). This experiment has measured a very impulsive noise near 10 kHz to be present about 20% of the time. It seems to be explainable as electric fields produced by ion sound waves that have been shifted in frequency by the solar wind velocity. The experiment has also detected, a few times each month, impulsive noise near 20 kHz which lasts 10-20 minutes. It appears that what is being observed are electron plasma oscillations in the interplanetary medium that are triggered by energetic electrons coming from the sun. As a final point, the experiment was able to measure auroral radiation near 100 kHz coming from the earth when Helios was over 20 Mkm away. The experiment has, however, not detected the intense low-frequency noise reported by Scarf *et al.* on the basis of Pioneer satellite measurements and so Gurnett seriously questions the validity of Scarf's results.

In the cosmic-ray area the results reported included the lack of any appreciable radial gradient from 0.3-1 AU in the galactic cosmic-ray intensity and a variation of intensity for solar cosmic rays with distance from the sun, R, as R^{-1} instead of R^{-2} (M. Van Hollebeke, University of Maryland); evidence that the particles in co-rotating solar proton streams are from the high-energy tail of the solar wind and are accelerated in interplanetary space (A. Richter, MPI Aeronomie and J. Trainor, Goddard Space Flight Center); indications that the He^3/He^4 ratio in solar cosmic-ray events originating in a single source region can change markedly, implying that there is a time-dependent differential acceleration mechanism (H. Hempe, University of Kiel); and evidence that electrons from Jupiter's magnetosphere are populating the inner solar system (J. Trainor).

Also in the cosmic ray area, a gamma ray burst experiment was added to the second Helios mission. The experiment has about 10-msec time resolution and has been detecting about two such bursts per month. Gamma-ray burst experiments with similar time-resolution were launched on two NRL Solrad satellites in March 1976. The long baseline, up to 2 AU, and good time-resolutions provided by these three satellites are expected to give the source positions for these bursts to within 1 arc min. This is appreciably better than the one degree positions now possible and should be good enough to allow source identifications.

The dust particle results have largely been reported in ESN 29-12:559.

Since that time, however, additional analysis of the zodiacal light data has shown that the scattering properties of the interplanetary dust do not change with radial distance from the sun. Furthermore, an upper limit of 20 solar radii has been determined for the size of any possible dust-free zone about the sun. Such a zone would be expected where evaporation of the dust grains becomes significant.

Finally, it is clear that this project has already produced a wealth of new data and that much more is coming. While there is an attempt to get approval for launching a third such Helios spacecraft to intercept the Comet Encke, it appears that this will not be approved and that the two Helios flights will be the last scientific satellites done by Germany as part of a national program. Instead, they will primarily depend on the ESA program, for which they are a major financial contributor, to provide space flight opportunities for their researchers. (L.H. Meredith)

SPACELAB ATMOSPHERIC PHYSICS

The European Space Agency (ESA) has a continuing program to identify the uses it will make of the US space shuttle. One capability of the shuttle will be to carry a laboratory into orbit. ESA is now building the basic housekeeping portions of such a laboratory, Spacelab. To help determine how Spacelab can be used to contribute to the solution of problems in atmospheric physics, ESA recently sponsored a three-day symposium at their ESRIN Laboratory facilities near Frascati, Italy. It was held from 11-14 May 1976 and was attended by about 75 people.

A study that addresses basically this same question has been in process in the US since 1970. The study is called AMPS and it now involves two contractors conducting engineering studies of a Spacelab atmospheric research facility. However, questions as to the viability of AMPS have been raised, and during the Frascati meeting it developed that the US National Academy of Sciences will probably sponsor a summer study of AMPS in 1976. Although there was strong US scientific representation at the meeting, the uncertainty of AMPS coupled with an uncertainty of the role the US would offer ESA in AMPS if it is approved, produced a rather confused situation throughout the sessions.

In the symposium there were a number of very good review papers outlining our current state of knowledge of various properties of the atmosphere, as well as some outlining the major scientific problems that need to be solved. In addition, there were a number of papers describing instruments which could be flown on Spacelab. However, there were only a very few cases in which an attempt was made to relate specific Spacelab experiments to the solution of specific important atmospheric questions. This was partly because a large portion of the European planning has been based on providing general-purpose types of experimental facilities which could be used to attack whatever atmospheric problems are of most importance when Spacelab becomes available in the early 1980's. Thus, reports were given on the ESA Spacelab subsatellite study (ESN 30-2:92) as well as on a recently completed ESA study that defined families of atmospheric passive sounding instruments for both nadir and horizon measurements. Most attention, however, was given to the ESA study of a laser-radar sounding facility, LIDAR. In part this was because the LIDAR study recently received what appeared to some as preferential treatment from ESA when they reviewed the initial phase of the LIDAR system study prior to reviewing other studies also presently competing for approval. This special treatment was caused by the long LIDAR development time, but whether it will help or hinder final LIDAR approval remains to be seen.

The initial phase of the LIDAR facility system study was conducted by CNES-Toulouse. Basically the facility is planned to include laser transmitting optics to send a short light-pulse into the atmosphere, and a one-meter receiving telescope to collect the backscattered radiation so that measurements of the signal as a function of time can be made. The design is such that on each flight there could be one or two lasers with average powers up to 2 1/2 kW. The system could operate anywhere within the 0.2 to 10.6 micron range, and facilities would be provided for detector packages of up to 50 kg from individual investigators. On the initial Spacelab flight, the telescope would be rigidly mounted and could be pointed only by moving the full shuttle. On later missions, a

capability to rock the telescope in the plane normal to the shuttle longitudinal axis would be included. The initial use of the facility would probably be to study atmospheric aerosols, but later flights with different lasers and detecting instruments might also study minor stratospheric constituents such as O_3 and NO_2, winds, cloud-top heights, the ocean surface, etc. While there were questions of whether the LIDAR would be able to do all that was hoped, there was general agreement that at least one flight of such a system to assess its capabilities would be appropriate.

The ability to try experiments, such as the LIDAR, in orbit prior to committing them to long-term flights on automated satellites was, of course, noted at the meeting as one of the unique capabilities of Spacelab. It was also noted, however, that long-term measurements from automated satellites that over-lap in time with the Spacelab flights will be required to put the relatively short-term, seven days, Spacelab measurements in their proper context for analysis. The reverse of this situation was also noted, namely, that Spacelab has the capability to perform calibrations of the long-term experiments carried on automated satellites. The primary example given of this was the calibration during their long life in orbit of instruments measuring the total energy being emitted by the sun, the solar constant.

Perhaps the type of experiment receiving the broadest support at the meeting was that of airglow television. This was reported on by Dr. P. Rothwell (University of Southampton), and was described previously in ESN 29-12:555. One of the primary reasons for this support was its relatively large area of coverage as opposed to the essentially individual point measurements of the other systems. This rapid aureal coverage is particularly important due to the shortness of the Spacelab flights.

The concluding comments to the symposium were given by Dr. E. Trendelenberg, Director of ESA's Scientific and Meteorological Programs. He noted that the question of whether Spacelab will be useful is one that always seems to be present, and he hoped that the use of Spacelab would not be forced upon investigators if the use of automated satellites or other systems would be better. He urged that the objectives of each mission be analyzed in terms of how best to obtain the necessary data rather than trying to invent things to do with Spacelab. It was perhaps unfortunate that his comments were not given at the start of the symposium instead of at the end. (L.H. Meredith)

TURKISH SPACE RESEARCH

In visiting space research laboratories in Europe, the difficulties of the researchers are generally found to be similar to those of researchers in the US. Thus, there are administrative problems, money is tight, the pressure is felt to make the research more relevant, etc., etc. However, I recently had the opportunity to visit Dr. H. Ogelman in the Physics Department at the Middle East Technical University. This university is located a few miles outside Ankara, Turkey and while the physical facilities are all relatively new and modern, the difficulties he is working to overcome include some that are significantly different from those to which most US researchers are accustomed. As one example, in Turkey there is an abudance of relatively cheap untrained labor. Thus there are people available specifically for such routine jobs as making coffee, calling elevators, etc. Over the years this has resulted in the feeling by many professional people that it is almost beneath their dignity to do physical work.

This has meant that researchers have tended toward theoretical studies as opposed to experimental laboratory research. To help develop experimentalists, Dr. Ogelman has established a machine shop for his students and trains them in its use. He also has them fabricate most of their own electronic systems. Both of these activities are, of course, in addition to the more standard laboratory training.

As another example, in Turkey a college education is essentially a requirement not only for obtaining a good position, but also for either sex to be able to make a "good" marriage. Thus, all students who can attend a university do so. However, each university department has a student quota. The result is that after the prestige departments such

as Engineering are full, the students join almost any department for which they are qualified so that they can graduate. In the Physics Department, for example, well over 80% of the undergraduate students initially wanted to be in some other department.

Finally, most US physics research groups take for granted the availability of electronic design technicians capable of working with transistor and integrated circuits. The relative lack of availability of such talent in Turkey is a major reason why Ogelman is actively training graduate students for such design work in addition to the fabrication work noted earlier.

It was refreshing to see, however, that these difficulties have added an additional sense of purpose to the research program rather than being stifling. For example, the projects of the group now include one to measure the amount of sodium in the atmosphere using an interferometer and a heliostat to scan the solar sodium Fraunhofer lines. This system has been in operation now for about three months. It is their intent to use the data to study atmospheric winds near 90 km altitude as well as sodium content changes. On another project, they are cooperating on the analysis of the gamma ray data from the US SAS-2 satellite. In addition to a Monte Carlo analysis of the track paths in the SAS-2 spark chamber in order to improve the system calibration, they are in the process of checking all the track identifications. So far, it looks as though this independent checking process will increase the number of detected gamma ray events by 10%. To try and improve the track identification reliability on future spark chamber satellite flights, they also have initiated the development of an automated gamma ray track identification system.

Their largest research program is aimed at studying the nature and origins of the light flashes produced in the atmosphere by the impact on the top of the atmosphere of energetic charged particles. To date, they have one telescope in Eastern Turkey and a three-telescope system at the University to observe such flashes. A new seven-telescope system has been constructed and is now being calibrated. While the system itself is relatively straightforward, when finished it will be operated in conjunction with the two existing systems to provide a moderately long baseline three-station ground network. The indications to date are that the observed flashes are produced by magnetospheric as opposed to cosmic particles. As Ogelman points out, however, whatever the origin turns out to be, the study is proving a good means for training experimental physicists. (L.H. Meredith)

NEWS & NOTES

<u>FORTHCOMING MEETING</u> A NATO-ONR sponsored Symposium on "Concepts in Marine Organic Chemistry" will be convened at the University of Edinburgh, 6-10 September 1976 just prior to the Joint Oceanographic Assembly. This Symposium will examine the present state of knowledge in the field of Organic Geochemistry, with particular emphasis being placed upon its marine aspects, in the context of the historical growth concepts (rather than detailed knowledge), the immediate growth anticipated (i.e., two-five years), and the degree to which our insight will remain limited by "pure ignorance" be judged. Therefore, the following problem areas will be considered in terms of concepts and their present status of knowledge, and will constitute the various sessions of the Symposium. Inputs; Inventories; Processes and Interactions; and Transport, Fate and Recycling. These topics will be examined, as appropriate, for each of the critical locations: a) Land sources, b) Air-Sea Interface and Euphatic Zone, c) Dissolved and Particulate Matter, d) Biota, and e) Sediment-Water Interface and Sedimentary Column.

Although attendance (participation) at the meeting is by invitation only, observers are welcome. There is no registration fee, however, cost of travel and per diem cannot be provided. Those wishing to attend as observers should contact Dr. Neil R. Andersen, Oceanography Section, National Science Foundation, Washington, DC 20550 before 15 August 1976, for further details.

<u>The Queen's Birthday Honours List</u> It appears that for the past few years, fewer and fewer scientists are receiving "honours" in the lists that come out twice a year. This

year is no exception. The highest award, that of Baron, was bestowed on Professor Asa Briggs, Vice-Chancellor of Sussex University. Knighthoods have been awarded to Dr. William Beynon, Professor of Physics at University College, Wales; Dr. Geoffrey Wilkinson, Professor of Inorganic Chemistry at Imperial College, London; and Dr. Frederic Williams, Professor of Electrical Engineering at the University of Manchester. The research councils were represented with CBE's awarded to Professor A.F. Posnette, Director of the East Malling Research Station, Agricultural Research Council; Dr. G.H. Stafford, Director of the Science Research Council's Rutherford Laboratory; and Professor P.M. Walker, Director of the Mammalian Genome Unit at the Medical Research Council.

France has recently announced "Distinctions et nominations" to members of the scientific community. For the Ordre National de la Légion d'Honneur Professor Jean Brenet, Co-director of the Laboratory of Electrochemistry of the Derivatives of Mineralmetallic and Organometallics, Strasbourg, has been named "officer"; and M. Paul Hagenmüller, Director of the Laboratory of Chemistry of Solids, Talence, has been named "Chevalier."

The Prize Paul Ehrlich 1976 has been awarded to Professor Georges Barski, Director of Research at the CNRS, who is responsible for the Laboratory of Virology and Tissue Culture at Villejuif, and to Professor Boris Ephrussi, Honorary Director of the Center of Molecular Genetics (CNRS) at Gif-sur-Yvette. The Prize is in recognition of their work and important fundamental discoveries in cellular biology and genetics. It constitutes the highest scientific distinction of the Federal Republic of Germany.

The "Oceaneering International Award," contributed for 1976 by the Undersea Medical Society, was bestowed upon M R. Naquet, Director of the Laboratory of Nerve Physiology, Gif-sur-Yvette; M J.C. Rostain, Research Attaché to CNRS; and M X. Fructus, COMEX, for their work in the field of underwater biomedical research.

PERSONAL

Dr. G.P. Blair, Reader in Mechanical Engineering, University of Belfast, has been appointed to the second Chair of Mechanical Engineering at that University.

Dr. A. Bull, Reader in Microbiology, University of Kent, has been appointed to the second Chair in Applied Biology at the University of Wales.

Dr. R.D. Chambers, Reader in Organic Chemistry, University of Durham, has been promoted to the Chair of Chemistry at that University.

Dr. J. Dickety, a Professor at New York State University, has been appointed to the Chair of Statistics at the University College of Wales at Aberystwyth.

Dr. R.R. Dils, Reader at the University of Nottingham, has been appointed Professor of Physiology and Biochemistry at the University of Reading.

Professor J.E. Enderby, Head of the Department of Physics, University of Leicester, has been appointed to the Chair of Physics, University of Bristol.

The title of Professor of Biophysics has been conferred on Dr. P. Fatt, at University College London.

Sir Frederick Dainton, Chairman of the University Grants Committee, and Abdol H. Samii, Iran's Minister of Science and Higher Education, have been appointed members of the Board of Trustees of the International Council for Development.

Dr. A.T. Florence, Senior Lecturer in Pharmaceutical Chemistry at the University of Strathclyde, has been appointed Professor in Pharmaceutical Technology at the University.

Dr. J.P. Frisby, Lecturer in the Department of Psychology, University of Sheffield, has been appointed to the Chair of Psychology at that University.

Dr. M.A. Gale, Senior Lecturer in Applied Psychology at the University of Wales Institute of Science and Technology, has been appointed to the second Chair of Psychology at the University of Southampton.

Dr. K.J. Gregory, Reader in Physical Geography at the University of Exeter, has been appointed to the second Chair of Geography at the University of Southampton.

Dr. M. Hart, Reader in Physics at Bristol University, has been appointed to the Wheatstone Chair of Physics at King's College, London.

Dr. G. Kelling, Reader in Geology, University College of Swansea, has been appointed to the Chair of Geology and the headship of the Geology Department, University of Keele.

Professor N. Kurti has had the title of Chevalier de la Légion d'Honour bestowed on him by the French government in recognition of his contribution towards greater scientific cooperation between France and Britain.

Dr. H.K. Moffatt, University Lecturer, Fellow and Senior Tutor, Trinity College, Cambridge, has been appointed to the Chair of Applied Mathematics at the University of Bristol.

Professor I.T. Millar, Head of the Department of Chemistry, University of Keele, has been promoted to the Chair of Chemistry at the University.

Dr. J. Reason, Reader in Psychology at the University of Leicester, has been appointed to a new Chair of Psychology at the University of Manchester.

The title of Professor of Chemical Engineering has been conferred on Dr. H. Sawistowski, Imperial College, London.

Mr. H.P. Williams, Lecturer in Operational Research at the University of Sussex, has been appointed to the newly founded Chair of Management Science at the University of Edinburgh.

ONRL REPORTS

R-4-76 "SUPERCONDUCTIVITY:" A CHANGING R & D SCENE IN GERMANY by R.A. Hein, Naval Research Laboratory, Washington, DC

Most of the German research and development associated with superconductivity is centered at the Institut für Experimental Kernphysiks at the Kernforschungszentrum in Karlsruhe and at Siemens AG Research Laboratories in Erlangen with some basic physics and materials studies at various universities and institutes. This report discusses the present status of research and development in superconductivity and remarks on the history, personnel, and outlook of the various programs in these German installations.

R-5-76 HOLOGRAPHIC GRATINGS AND ZONE PLATES By W.R. Hunter, Naval Research Laboratory, Washington, DC

This report is a tutorial treatment of diffraction gratings and zone plates, with emphasis on modern holographic methods of generating these optical components. The report is based upon recent visits to several research establishments in the UK and on the Continent.

C-10-76 THE FIFTH INTERNATIONAL BIOPHYSICS CONGRESS: FOUR VIEWS by M. Blank, J.W. Twidell, R.J. Werrlein, J.B. Bateman

A report by four participants dealing with different aspects of the conference including: Emphasis on Membranes; Active Transport; Electrophysiology of Nerve Membranes; Interaction of Light with Cells; Cell Shape; Wider Applications of Biophysics; Membrane Bound Enzyme Systems; Education in Biophysics; Gating Currents; Membrane Noise Analysis; the Nature of Biophysics; the Future of Large International Meetings; Biophysical Aspects of Global Problems such as Changes in the Upper Atmosphere, Emission of Radioactive Gases by Reactors, Mechanisms of Chemical Carcinogenesis.

C-12-76 FIFTH INTERNATIONAL SYMPOSIUM ON BORON AND BORIDES by Forrest L. Carter (NRL, Washington, DC) and Charles Feldman (APL, Johns Hopkins Univ. Laurel, MD)

The Fifth International Symposium on Boron and Borides was held at the University of Bordeaux, Talence, France, on 8-11 September, 1975. The conference emphasized the relation of crystal structure and chemical bonding to properties and applications but,other major topics included reaction kinetics in the preparation of amorphous boron, vibration and optical spectra, band structure, and magnetic and semiconducting properties. In the area of applications the main topics included the surface treatment of steel for wear resistance, the hardness of boron and borides, and the protection of boron fibers in metallic composite materials.

C-13-76 IMAGING IN MEDICINE: THE SEVENTH L.H. GRAY CONFERENCE, LEEDS, 1976 by J.H. Schulman

This topical conference provided an excellent introduction to fundamental aspects of medical image formation and interpretation as well as an account of the current state of the art and a forecast of future techniques. Methods of image formation considered were: x-rays (ionography and computerized tomography), radionuclides, ultrasonics (macro-imaging and acoustic microscopy), thermography, and nuclear magnetic resonance. Special emphasis was given to the problems of image perception, image processing and extraction of numerical information from images. This Report discusses some highlights of the Conference and gives the full Conference program as an appendix.

C-14-76 ENERGY AND PHYSICS -- THIRD GENERAL CONFERENCE OF THE EUROPEAN PHYSICAL SOCIETY by Roy F. Potter

The Third General Conference of the European Physical Society, held in Bucharest, Romania on 9-12 Sept. 1975, and entitled Energy and Physics, was organized into plenary sessions as well as several parallel sessions. Most plenary sessions were devoted to applied and fundamental aspects of modern energy technologies. These and other topics such as astrophysics, many-body problems, elementary particles, were developed further by invited speakers at the parallel sessions. This report covers portions of most of the plenary sessions including the opening session of the Conference, Physics and Energy (Kapitza), Energy Strategies (Häfele), Maturity of Nuclear Energy (Weinberg), Use of Solar Energy (Aigrain), Energy Today: New Goals and Challenges (Ursu), Photochemistry (Archer), Thermonuclear Research (Braams), Energy, Dissipation and Structure (Nicolis), Transport and Storage of Energy (Marchetti). Other sessions covered are on solar energy use, transport and storage of energy and energy research strategies.

C-15-76 THE WORLD OF SUB-SENSORY RECEPTORS: A SYMPOSIUM ON DRUG ACTION AT THE MOLECULAR LEVEL, by J.B. Bateman

This brief report has been built around the facts presented, and impressions received, at a recent symposium on "Drug Action at the Molecular Level." Some background material has been included and the sequence of presentations rearranged so as to illustrate two points that seemed to be implied in the topics chosen by the organizers: (1) The methods currently in use in the investigation of the substrate-receptor relationship, and (2) The relationship between properties and functions of a series of enzymes. Concerning (1) special attention is paid to the attempt to bypass the dominant empirical approach by selecting a well-characterized element of macromolecular structure as "receptor" and designing a "substrate" or "drug" for it on the basis of detailed structural information. In (2) a comparison is made of the characteristics of selected enzymes performing functions related to acid base control, active transport, replication, neuromuscular transmission and drug catabolism.

NOTE: This report was erroneously shown in ESN 30-6:260 as Report C-13-76.

C-16-76 CONFERENCE ON MAGNETOSPHERIC AND PARTICLE PHYSICS by Maj. M.S. Harris, EOARD

A conference on Magnetospheric and Particle Physics was held during 31 March-2 April 1976 at the University of Sheffield sponsored by the Institute of Physics and the Royal Astronomical Society. The meeting covered the topics of reconnection and convection, structure and stability, particles and their origins, waves, fields, and pulsations in the magnetosphere.

C-17-76 FIFTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA by Robert H. Nunn

This report summarizes the nature and scope of the subject conference which attracted some 495 delegates from 34 countries on 16-20 May 1976. The subject-coverage of the Symposium is briefly reviewed, and a somewhat more complete description is given of the sessions on Regional Reviews, Economics, and of the use of fluidized beds in evaporative systems. Economy was emphasized in the conference, with major implications regarding the future of multi-stage flash evaporation systems in the presence of rising fuel costs.

C-18-76 WORKSHOP ON THE TREATMENT OF DECOMPRESSION SICKNESS by LCDR K.M. Greene, MC, USN

This report summarizes a workshop held 17-18 February 1976 in London. The 30 physicians attending from seven nations sought a uniform approach to the treatment of decompression sickness in the North Sea environment. Aspects considered include recompression profiles, gas mixtures, ancillary drugs, aftercare, qualifications of assistants, and communication problems. Included in the report is an outline approved by the EUBS for guidance in the choice of treatment tables.

C-19-76 SECOND INTERNATIONAL HEAT PIPE CONFERENCE, BOLOGNA, ITALY by LTCOL Robert F. Lopina, EAORD

This report summarizes the presentations at a three-day international meeting on heat pipe research and developments. The meeting dealt with gravity-assist heat pipes, low temperature heat pipes, variable conductance heat pipes, rotating heat pipes, heat-pipe materials, evaporative heat transfer mechanisms, zero-gravity testing and terrestrial spacecraft applications of heat pipes.